

Construction Trades and Related Occupations



Reprinted from the
Occupational Outlook Handbook, 2002-03 Edition

U.S. Department of Labor
Bureau of Labor Statistics

February 2002

Bulletin 2540-15



Occupations Included in this Reprint

Boilermakers
Brickmasons, blockmasons, and stonemasons
Carpenters
Carpet, floor, and tile installers and finishers
Cement masons, concrete finishers, segmental pavers,
and terrazzo workers
Construction and building inspectors
Construction equipment operators
Construction laborers
Drywall installers, ceiling tile installers, and tapers
Electricians
Elevator installers and repairers
Glaziers
Hazardous materials removal workers
Insulation workers
Painters and paperhangers
Pipelayers, plumbers, pipefitters, and steamfitters
Plasterers and stucco masons
Roofers
Sheet metal workers
Structural and reinforcing iron and metal workers
Welding, soldering, and brazing workers
Woodworkers

Boilermakers

(O*NET 47-2011.00)

Significant Points

- A formal apprenticeship is the best way to learn this trade.
- Due to the limited number of apprenticeships available and the relatively good wages, prospective boilermakers are likely to face competition.

Nature of the Work

Boilermakers and boilermaker mechanics make, install, and repair boilers, vats, and other large vessels that hold liquids and gases. Boilers supply steam to drive huge turbines in electric power plants and to provide heat and power in buildings, factories, and ships. Tanks and vats are used to process and store chemicals, oil, beer, and hundreds of other products.

Boilers and other high-pressure vessels usually are made in sections, by casting each piece out of molten iron or steel. Manufacturers are increasingly automating this process to increase the quality of these vessels. Boiler sections are then welded together, often using automated orbital welding machines, which make more consistent welds than are possible by hand. Small boilers may be assembled in the manufacturing plant; larger boilers usually are assembled on site.

Following blueprints, boilermakers locate and mark reference points on the boiler foundation, using straightedges, squares, transits, and tape measures. Boilermakers attach rigging and signal crane operators to lift heavy frame and plate sections and other parts into place. They align sections, using plumb bobs, levels, wedges, and turnbuckles. Boilermakers use hammers, files, grinders, and cutting torches to remove irregular edges, so that edges fit properly. They then bolt or weld edges together. Boilermakers align and attach water tubes, stacks, valves, gauges, and other parts and test complete vessels for leaks or other defects. They also install refractory brick and other heat-resistant materials in fireboxes or pressure vessels. Usually, they assemble large vessels temporarily in a fabrication shop to ensure a proper fit before final assembly on the permanent site.

Because boilers last a long time—35 years or more—boilermakers regularly maintain them and update components, such as burners and boiler tubes, to increase efficiency. Boilermaker mechanics

maintain and repair boilers and similar vessels. They inspect tubes, fittings, valves, controls, and auxiliary machinery and clean or supervise the cleaning of boilers using scrapers, wire brushes, and cleaning solvents. They repair or replace defective parts, using hand and power tools, gas torches, and welding equipment, and may operate metalworking machinery to repair or make parts. They also dismantle leaky boilers, patch weak spots with metal stock, replace defective sections, and strengthen joints.

Working Conditions

Boilermakers often use potentially dangerous equipment, such as acetylene torches and power grinders, handle heavy parts, and work on ladders or on top of large vessels. Work may be done in cramped quarters inside boilers, vats, or tanks that are often damp and poorly ventilated. To reduce the chance of injuries, boilermakers may wear hardhats, harnesses, protective clothing, safety glasses and shoes, and respirators. Boilermakers usually work a 40-hour week, but may experience extended periods of overtime when equipment is shut down for maintenance. Overtime work also may be necessary to meet construction or production deadlines.

Employment

Boilermakers held about 27,000 jobs in 2000. Nearly 6 out of 10 worked in the construction industry, assembling and erecting boilers and other vessels. About one-fifth worked in manufacturing, primarily in boiler manufacturing shops, iron and steel plants, petroleum refineries, chemical plants, and shipyards. Some also worked for boiler repair firms, railroads, or in Navy shipyards and Federal power facilities.

Training, Other Qualifications, and Advancement

Many boilermakers learn this trade through a formal apprenticeship. Others become boilermakers through a combination of trade or technical school training and employer-provided training. Apprenticeship programs usually consist of 4 years of on-the-job training, supplemented by 144 hours of classroom instruction each year in subjects such as set-up and assembly rigging, welding of all types, blueprint reading, and layout. Experienced boilermakers often attend apprenticeship classes to keep their knowledge current. Also, the American Boiler Manufacturers Association, in conjunction with the National Board of Boiler and Pressure Vessel Operators, offers seminars on boiler equipment, operation, maintenance, and safety. When an apprenticeship becomes available, the local union publicizes the opportunity by notifying local vocational schools and high school vocational programs.

When hiring helpers, employers prefer high school or vocational school graduates. Courses in shop, mathematics, drafting, blueprint reading, welding, and machine metalworking are useful. Mechanical aptitude and the manual dexterity needed to handle tools also are important.

Some boilermakers advance to supervisory positions. Because of their broader training, apprentices usually have an advantage in promotion.

Job Outlook

Employment of boilermakers is expected to show little or no change through the year 2010. Most job openings will result from the need to replace experienced workers who leave this small occupation. Growth should be limited by the trend toward repairing and retrofitting, rather than replacing, existing boilers; the use of small boilers, which require less on-site assembly; and automation of production technologies.

Most industries that purchase boilers are sensitive to economic conditions. Therefore, during economic downturns, construction



Boilermakers maintain and repair boilers and similar vessels.

boilermakers may be laid off. However, because maintenance and repairs of boilers must continue even during economic downturns, boilermaker mechanics generally have stable employment.

Earnings

In 2000, the median hourly earnings of boilermakers were about \$17.80. The middle 50 percent earned between \$14.06 and \$23.19. The lowest 10 percent earned less than \$9.60 and the highest 10 percent earned more than \$26.81. Apprentices generally start at about 60 percent of journey wages, with wages gradually increasing to the journey wage as progress is made in the apprenticeship.

Almost one-half of all boilermakers belong to labor unions. The principal union is the International Brotherhood of Boilermakers. Other boilermakers are members of the International Association of Machinists, the United Automobile Workers, or the United Steelworkers of America.

Related Occupations

Workers in a number of other occupations assemble, install, or repair metal equipment or machines. These occupations include assemblers and fabricators; machinists; industrial machinery installation, repair, and maintenance workers; pipelayers, plumbers, pipefitters, and steamfitters; sheet metal workers; tool and die makers; and welding, soldering, and brazing workers.

Sources of Additional Information

For further information regarding boilermaking apprenticeships or other training opportunities, contact local offices of the unions previously mentioned, local construction companies and boiler manufacturers, or the local office of your State Employment Service.

For information on apprenticeships and the boilermaking occupation, contact:

► International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers, and Helpers, 753 State Ave., Suite 570, Kansas City, KS 66101. Internet: <http://www.boilermakers.org>

Brickmasons, Blockmasons, and Stonemasons

(O*NET 47-2021.00, 47-2022.00)

Significant Points

- Job prospects are expected to be excellent.
- Most entrants learn informally on the job, but apprenticeship programs provide the most thorough training.
- Work is usually outdoors and involves lifting heavy bricks and blocks and working on scaffolds.
- Nearly 3 out of 10 are self-employed.

Nature of the Work

Brickmasons, blockmasons, and stonemasons work in closely related trades creating attractive, durable surfaces and structures. The work varies in complexity, from laying a simple masonry walkway to installing an ornate exterior on a high-rise building. *Brickmasons* and *blockmasons*—who often are referred to simply as bricklayers—build and repair walls, floors, partitions, fireplaces, chimneys, and other structures with brick, precast masonry panels, concrete block, and other masonry materials. Additionally, brickmasons

specialize in installing firebrick linings in industrial furnaces. *Stonemasons* build stone walls, as well as set stone exteriors and floors. They work with two types of stone—natural cut, such as marble, granite, and limestone; and artificial stone made from concrete, marble chips, or other masonry materials. Stonemasons usually work on nonresidential structures, such as houses of worship, hotels, and office buildings.

When building a structure, brickmasons use one of two methods, the corner lead or the corner pole. Using the corner lead method, they begin by constructing a pyramid of bricks at each corner—called a lead. After the corner leads are complete, less experienced brickmasons fill in the wall between the corners, using a line from corner to corner to guide each *course*, or layer, of brick. Due to the precision needed, corner leads are time-consuming to erect and require the skills of experienced bricklayers.

Because of the expense associated with building corner leads, most brickmasons use corner poles, also called masonry guides, that enable them to build an entire wall at the same time. They fasten the corner poles (posts) in a plumb position to define the wall line and stretch a line between them. This line serves as a guide for each course of brick. Brickmasons then spread a bed of mortar (a cement, sand, and water mixture) with a trowel (a flat, bladed metal tool with a handle), place the brick on the mortar bed, and press and tap the brick into place. Depending on blueprint specifications, brickmasons either cut bricks with a hammer and chisel or saw them to fit around windows, doors, and other openings. Mortar joints are then finished with jointing tools for a sealed, neat, uniform appearance. Although brickmasons usually use steel supports, or *lintels*, at window and door openings, they sometimes build brick arches instead, which support and enhance the beauty of the brickwork.

Stonemasons often work from a set of drawings, in which each stone has been numbered for identification. Helpers may locate and carry these prenumbered stones to the masons. A derrick operator using a hoist may be needed to lift large stone pieces into place.

When building a stone wall, masons set the first course of stones into a shallow bed of mortar. They then align the stones with wedges, plumb lines, and levels, and adjust them into position with a hard rubber mallet. Masons continue to build the wall by alternating layers of mortar and courses of stone. As the work progresses, masons remove the wedges, fill the joints between stones, and use a pointed metal tool, called a tuck pointer, to smooth the mortar to an attractive finish. To hold large stones in place, stonemasons attach brackets to the stone and weld or bolt these brackets to anchors in the wall. Finally, masons wash the stone with a cleansing solution to remove stains and dry mortar.

When setting stone floors, which often consist of large and heavy pieces of stone, masons first use a trowel to spread a layer of damp mortar over the surface to be covered. Using crowbars and hard rubber mallets for aligning and leveling, they then set the stone in the mortar bed. To finish, workers fill the joints and wash the stone slabs.

Masons use a special hammer and chisel to cut stone. They cut stone along the grain to make various shapes and sizes, and valuable pieces often are cut with a saw that has a diamond blade. Some masons specialize in setting marble which, in many respects, is similar to setting large pieces of stone. Brickmasons and stonemasons also repair imperfections and cracks, and replace broken or missing masonry units in walls and floors.

Most nonresidential buildings now are built with walls made of concrete block, brick veneer, stone, granite, marble, tile, or glass. In the past, brickmasons and blockmasons doing nonresidential interior work mostly built block partition walls and elevator shafts.



Job opportunities for brickmasons, blockmasons, and stonemasons are expected to be excellent.

Now, these workers must be more versatile and work with many materials. For example, some brickmasons and blockmasons now install structural insulated wall panels and masonry accessories used in many high-rise buildings.

Refractory masons are brickmasons who specialize in installing firebrick and refractory tile in high-temperature boilers, furnaces, cupolas, ladles, and soaking pits in industrial establishments. Most of these workers work in steel mills, where molten materials flow on refractory beds from furnaces to rolling machines.

Working Conditions

Brickmasons, blockmasons, and stonemasons usually work outdoors and are exposed to the elements. They stand, kneel, and bend for long periods and often have to lift heavy materials. Common hazards include injuries from tools and falls from scaffolds, but these can often be avoided when proper safety practices are followed.

Employment

Brickmasons, blockmasons, and stonemasons held about 158,000 jobs in 2000. The vast majority were brickmasons. Workers in these crafts are employed primarily by building, special trade, or general contractors. Brickmasons, blockmasons, and stonemasons work throughout the country but, like the general population, are concentrated in metropolitan areas.

Nearly 3 out of 10 brickmasons, blockmasons, and stonemasons are self-employed. Many of the self-employed specialize in contracting small jobs, such as patios, walkways, and fireplaces.

Training, Other Qualifications, and Advancement

Most brickmasons, blockmasons, and stonemasons pick up their skills informally, observing and learning from experienced workers. Many others receive training in vocational education schools or from industry-based programs that are common throughout the country. Another way to learn these skills is through an apprenticeship program, which generally provides a thorough training.

Individuals who learn the trade on the job usually start as helpers, laborers, or mason tenders. These workers carry materials, move scaffolds, and mix mortar. When the opportunity arises, they learn from experienced craftworkers how to spread mortar, lay brick and block, or set stone. As they gain experience, they make the

transition to full-fledged craftworkers. The learning period on the job normally lasts longer than an apprenticeship program. Industry-based programs offered through companies usually last between 2 and 4 years.

Apprenticeships for brickmasons, blockmasons, and stonemasons usually are sponsored by local contractors or by local union-management committees. The apprenticeship program requires 3 years of on-the-job training, in addition to a minimum 144 hours of classroom instruction each year in subjects such as blueprint reading, mathematics, layout work, and sketching.

Apprentices often start by working with laborers, carrying materials, mixing mortar, and building scaffolds. This period generally lasts about a month and familiarizes the apprentice with job routines and materials. Next, they learn to lay, align, and join brick and block. Apprentices also learn to work with stone and concrete, which enables them to be certified to work with more than one masonry material.

Applicants for apprenticeships must be at least 17 years old and in good physical condition. A high school education is preferable; and courses in mathematics, mechanical drawing, and shop are helpful. The International Masonry Institute (IMI), a joint trust of the International Union of Bricklayers and Allied Craftworkers and the contractors who employ its members, operates training centers in several large cities that help jobseekers develop the skills needed to successfully complete the formal apprenticeship program. In view of the shortage of entrants, IMI has expanded these centers in recent years to recruit and train workers before they enter apprenticeship programs. In addition, the IMI has a national training and education center at Fort Ritchie, MD. The national center's programs teach basic job skills for brick, stone, tile, terrazzo, refractory, and restoration work, as well as safety and scaffolding training.

Bricklayers who work in nonresidential construction usually work for large contractors and receive well-rounded training—normally through apprenticeship in all phases of brick or stone work. Those who work in residential construction usually work primarily for small contractors and specialize in only one or two aspects of the job.

Often, experienced workers can advance to supervisory positions or become estimators. They also can open contracting businesses of their own.

Job Outlook

Job opportunities for brickmasons, blockmasons, and stonemasons are expected to be excellent through 2010—largely due to the numerous openings arising each year as experienced workers leave the occupation. In addition, many potential workers prefer to work under less strenuous, more comfortable conditions. Well trained workers will have especially favorable opportunities.

Employment of brickmasons, blockmasons, and stonemasons is expected to increase about as fast as the average for all occupations over the 2000-10 period as population and business growth create a need for new houses, industrial facilities, schools, hospitals, offices, and other structures. Also stimulating demand will be the need to restore a growing stock of old masonry buildings, as well as the increasing use of brick and stone for decorative work on building fronts and in lobbies and foyers. Brick exteriors should continue to be very popular, as the trend continues toward durable exterior materials requiring little maintenance. However, employment of bricklayers who specialize in refractory repair will decline, along with employment in other occupations in the primary metal industries. In addition, many openings will result from the need to replace brickmasons, blockmasons, and stonemasons who

retire, transfer to other occupations, or leave these trades for other reasons.

Employment of brickmasons, blockmasons, and stonemasons, like that of many other construction workers, is sensitive to changes in the economy. When the level of construction activity falls, workers in these trades can experience periods of unemployment.

Earnings

Median hourly earnings of brickmasons and blockmasons in 2000 were \$19.37. The middle 50 percent earned between \$15.00 and \$24.48. The lowest 10 percent earned less than \$11.20, and the highest 10 percent earned more than \$30.02. Median hourly earnings in the industries employing the largest number of brickmasons in 2000 are shown below:

Miscellaneous special trade contractors	\$22.87
Masonry, stonework, and plastering	19.55
Nonresidential building construction	19.02
Residential building construction	18.10

Median hourly earnings of stonemasons in 2000 were \$14.98. The middle 50 percent earned between \$10.78 and \$19.24. The lowest 10 percent earned less than \$9.09, and the highest 10 percent earned more than \$23.03.

Earnings for workers in these trades can be reduced on occasion because poor weather and downturns in construction activity limit the time they can work.

Apprentices or helpers usually start at about 50 percent of the wage rate paid to experienced workers. Pay increases as apprentices gain experience and learn new skills.

Some brickmasons, blockmasons, and stonemasons are members of the International Union of Bricklayers and Allied Craftworkers.

Related Occupations

Brickmasons, blockmasons, and stonemasons combine a thorough knowledge of brick, concrete block, stone, and marble with manual skill to erect attractive, yet highly durable, structures. Workers in other occupations with similar skills include carpet, floor, and tile installers and finishers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; and plasterers and stucco masons.

Sources of Additional Information

For details about apprenticeships or other work opportunities in these trades, contact local bricklaying, stonemasonry, or marble-setting contractors; a local of the union listed above; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or apprenticeship agency.

For general information about the work of brickmasons, blockmasons, or stonemasons, contact:

- International Union of Bricklayers and Allied Craftworkers, 1776 I St. NW., Washington, DC. 20006. Internet: <http://www.bacweb.org>
- International Masonry Institute, Apprenticeship and Training, 837 Buena Vista Ave., Cascade, MD 21719. Internet: <http://www.imiweb.org>

Information about the work of bricklayers also can be obtained from:

- Associated General Contractors of America, Inc., 1957 E St. NW., Washington, DC 20006. Internet: <http://www.agc.org>
- Brick Industry Association, 11490 Commerce Park Dr., Reston, VA 22091-1525. Internet: <http://www.brickinfo.org>
- National Association of Home Builders, 1201 15th St. NW., Washington, DC 20005. Internet: <http://www.nahb.com>
- National Concrete Masonry Association, 2302 Horse Pen Rd., Herndon, VA 20171-3499. Internet: <http://www.ncma.org>

Carpenters

(O*NET 47-2031.01, 47-2031.02, 47-2031.03, 47-2031.04, 47-2031.05, 47-2031.06)

Significant Points

- More than one-fourth of all carpenters—the largest construction trade in 2000—were self-employed.
- Job opportunities should be excellent, in part because of the large number of job openings created by carpenters who leave the occupation each year.
- Many builders use specialty carpentry subcontractors who do one or two work activities, so versatile carpenters able to switch specialties should have the best opportunities for steady work.

Nature of the Work

Carpenters are involved in many different kinds of construction activity. They cut, fit, and assemble wood and other materials for the construction of buildings, highways, bridges, docks, industrial plants, boats, ships, and many other structures. Carpenters also build doors or brattices (ventilation walls or partitions) in underground passageways to control the proper circulation of air through these passageways and to worksites. Carpenters' duties vary by type of employer. Builders increasingly are using specialty trade contractors who, in turn, hire carpenters who specialize in just one or two activities. Some of these activities are setting forms for concrete construction; erecting scaffolding; or doing finishing work, such as installing interior and exterior trim. However, a carpenter directly employed by a general building contractor often must perform a variety of the tasks associated with new construction, such as framing walls and partitions, putting in doors and windows, building stairs, laying hardwood floors, and hanging kitchen cabinets.

Because local building codes often dictate where certain materials can be used, carpenters must know these regulations. Each carpentry task is somewhat different, but most involve the same basic steps. Working from blueprints or instructions from supervisors, carpenters first do the layout—measuring, marking, and arranging materials. They cut and shape wood, plastic, fiberglass, or drywall, using hand and power tools, such as chisels, planes, saws, drills, and sanders. They then join the materials with nails, screws, staples, or adhesives. In the final step, carpenters check the accuracy of their work with levels, rules, plumb bobs, and framing squares, and make any necessary adjustments. When working with prefabricated components, such as stairs or wall panels, the carpenter's task is somewhat simpler than above, because it does not require as much layout work or the cutting and assembly of as many pieces. Prefabricated components are designed for easy and fast installation and generally can be installed in a single operation.

Carpenters who remodel homes and other structures must be able to do all aspects of a job—not just one task. Thus, individuals with good basic overall training are at a distinct advantage, because they can switch from residential building to commercial construction or remodeling work, depending on which offers the best work opportunities.

Carpenters employed outside the construction industry perform a variety of installation and maintenance work. They may replace panes of glass, ceiling tiles, and doors, as well as repair desks, cabinets, and other furniture. Depending on the employer, carpenters install partitions, doors, and windows; change locks; and repair broken furniture. In manufacturing firms, carpenters may assist in



Some carpenters specialize in framing walls and partitions.

moving or installing machinery. (For more information on workers who install machinery, see the section on industrial machinery installation, repair, and maintenance workers elsewhere in the *Handbook*.)

Working Conditions

As in other building trades, carpentry work is sometimes strenuous. Prolonged standing, climbing, bending, and kneeling often are necessary. Carpenters risk injury working with sharp or rough materials, using sharp tools and power equipment, and working in situations where they might slip or fall. Additionally, many carpenters work outdoors, which can be uncomfortable.

Some carpenters change employers each time they finish a construction job. Others alternate between working for a contractor and working as contractors themselves on small jobs.

Employment

Carpenters, the largest group of building trades workers, held about 1.2 million jobs in 2000. One-third worked for general building contractors, 20 percent worked for special trade contractors, and 12 percent worked in heavy construction. Most of the remainder worked for manufacturing firms, government agencies, wholesale and retail establishments, or schools. More than one-fourth of all carpenters were self-employed.

Carpenters are employed throughout the country in almost every community.

Training, Other Qualifications, and Advancement

Carpenters learn their trade through on-the-job training, as well as formal training programs. Most pick up skills informally by working under the supervision of experienced workers. Many acquire skills through vocational education. Others participate in employer training programs or apprenticeships.

Most employers recommend an apprenticeship as the best way to learn carpentry. Apprenticeship programs are administered by local joint union-management committees of the United Brotherhood of Carpenters and Joiners of America, the Associated General Contractors, Inc., and the National Association of Home Builders. In addition, training programs are administered by local chapters of the Associated Builders and Contractors and by local chapters of the Associated General Contractors, Inc. These programs combine on-the-job training with related classroom instruction.

On the job, apprentices learn elementary structural design and become familiar with common carpentry jobs, such as layout, form building, rough framing, and outside and inside finishing. They also learn to use the tools, machines, equipment, and materials of the trade. Apprentices receive classroom instruction in safety, first aid, blueprint reading, freehand sketching, basic mathematics, and different carpentry techniques. Both in the classroom and on the job, they learn the relationship between carpentry and the other building trades.

Usually, apprenticeship applicants must be at least 17 years old and meet local requirements. For example, some union locals test an applicant's aptitude for carpentry. The length of the program, usually about 3 to 4 years, varies with the apprentice's skill. Because the number of apprenticeship programs is limited, however, only a small proportion of carpenters learn their trade through these programs.

Informal on-the-job training is normally less thorough than an apprenticeship. The degree of training and supervision often depends on the size of the employing firm. A small contractor specializing in homebuilding may provide training only in rough framing. In contrast, a large general contractor may provide training in several carpentry skills. Although specialization is becoming increasingly common, it is important to try to acquire skills in all aspects of carpentry and to have the flexibility to perform any kind of work.

A high school education is desirable, including courses in carpentry, shop, mechanical drawing, and general mathematics. Manual dexterity, eye-hand coordination, physical fitness, and a good sense of balance are important. The ability to solve arithmetic problems quickly and accurately also is helpful. Employers and apprenticeship committees generally view favorably any training and work experience obtained in the Armed Services or Job Corps.

Carpenters may advance to carpentry supervisor or general construction supervisor positions. Carpenters usually have greater opportunities than most other construction workers to become general construction supervisors, because carpenters are exposed to the entire construction process. Some carpenters become independent contractors. To advance, these workers should be able to estimate the nature and quantity of materials needed to properly complete a job. In addition, they must be able to accurately estimate how long a job should take to complete and what it will cost.

Job Outlook

Job opportunities for carpenters are expected to be excellent over the 2000-10 period, largely due to the numerous openings arising each year from experienced carpenters who leave this large occupation each year. In addition, many potential workers may prefer work that is less strenuous and that has more comfortable working conditions. Because there are no strict training requirements for entry, many people with limited skills take jobs as carpenters but

eventually leave the occupation because they dislike the work or cannot find steady employment. Well-trained workers will have especially favorable opportunities.

Employment of carpenters is expected to increase more slowly than the average for all occupations. Construction activity should increase in response to demand for new housing and commercial and industrial plants and the need to renovate and modernize existing structures. The demand for larger homes with more amenities and for second homes will continue to rise, especially as the baby boomers reach their peak earning years and can afford to spend more on housing. At the same time, as the number of immigrants increase and as the echo boomers (the children of the baby boomers) replace the smaller baby bust generation in the young adult age groups, the demand for manufactured housing, starter homes, and rental apartments also is expected to increase.

However, some of the demand for carpenters will be offset by expected productivity gains resulting from the increasing use of prefabricated components, such as pre-hung doors and windows and prefabricated wall panels and stairs, which can be installed very quickly. Prefabricated walls, partitions, and stairs can be lifted into place in one operation; beams—and in some cases entire roof assemblies—can be lifted into place using a crane. As prefabricated components become more standardized, builders will use them more often. In addition, improved adhesives will reduce the time needed to join materials, and lightweight, cordless pneumatic and combustion tools—such as nailers and drills—all make carpenters more efficient.

Carpenters can experience periods of unemployment because of the short-term nature of many construction projects and the cyclical nature of the construction industry. Building activity depends on many factors—interest rates, availability of mortgage funds, the season, government spending, and business investment—that vary with the state of the economy. During economic downturns, the number of job openings for carpenters declines. New and improved tools, equipment, techniques, and materials have vastly increased carpenter versatility. Therefore, carpenters with all-round skills will have better opportunities than those who can do only a few relatively simple, routine tasks.

Job opportunities for carpenters also vary by geographic area. Construction activity parallels the movement of people and businesses and reflects differences in local economic conditions. Therefore, the number of job opportunities and apprenticeship opportunities in a given year may vary widely from area to area.

Earnings

In 2000, median hourly earnings of carpenters were \$15.69. The middle 50 percent earned between \$11.99 and \$20.86. The lowest 10 percent earned less than \$9.48, and the highest 10 percent earned more than \$26.73. Median hourly earnings in the industries employing the largest numbers of carpenters in 2000 are shown below:

Masonry, stonework, and plastering	\$19.27
Nonresidential building construction	17.43
Heavy construction, except highway	16.74
Carpentry and floor work	15.51
Residential building construction	15.26

Earnings can be reduced on occasion, because carpenters lose worktime in bad weather and during recessions when jobs are unavailable.

Some carpenters are members of the United Brotherhood of Carpenters and Joiners of America.

Related Occupations

Carpenters are skilled construction workers. Workers in other skilled construction occupations include brickmasons, blockmasons, and

stonemasons; cement masons, concrete finishers, segmental pavers, and terrazzo workers; electricians; pipelayers, plumbers, pipefitters, and steamfitters; and plasterers and stucco masons.

Sources of Additional Information

For information about carpentry apprenticeships or other work opportunities in this trade, contact local carpentry contractors, locals of the union mentioned above, local joint union-contractor apprenticeship committees, or the nearest office of the State employment service or apprenticeship agency.

For information on training opportunities and carpentry in general, contact:

- Associated Builders and Contractors, 1300 N. 17th St., Suite 800, Arlington, VA 22209. Internet: <http://www.abc.org>
- Associated General Contractors of America, Inc., 1957 E St. NW., Washington, DC 20006. Internet: <http://www.agc.org>
- National Association of Home Builders, 1201 15th St. NW., Washington, DC 20005. Internet: <http://www.nahb.com>
- United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, DC 20001. Internet: <http://www.necarpenters.org/ubc.htm>

Carpet, Floor, and Tile Installers and Finishers

(O*NET 47-2041.00, 47-2042.00, 47-2043.00, 47-2044.00)

Significant Points

- Almost half of all carpet, floor, and tile installers and finishers are self-employed, compared with fewer than 1 in 5 of all construction trades and related workers.
- Most workers learn on the job.
- Carpet installers, the largest specialty, should have the best job opportunities.
- Carpet, floor, and tile installers and finishers are less sensitive to fluctuations in construction activity than are other construction trades workers.

Nature of the Work

Carpet, tile, and other types of floor coverings not only serve an important basic function in buildings, but their decorative qualities also contribute to the appeal of the buildings. Carpet, floor, and tile installers and finishers lay these floor coverings in homes, offices, hospitals, stores, restaurants, and many other types of buildings. Tile also is installed on walls and ceilings.

Before installing carpet, *carpet installers* first inspect the surface to be covered to determine its condition and, if necessary, correct any imperfections that could show through the carpet or cause the carpet to wear unevenly. They must measure the area to be carpeted and plan the layout, keeping in mind expected traffic patterns and placement of seams for best appearance and maximum wear.

When installing wall-to-wall carpet without tacks, installers first fasten a tackless strip to the floor, next to the wall. They then install the padded cushion or underlay. Next, they roll out, measure, mark, and cut the carpet, allowing for 2 to 3 inches of extra carpet for the final fitting. Using a device called a “knee kicker,” they position the carpet, stretching it to fit evenly on the floor and snugly against each wall and door threshold. They then rough cut the excess carpet. Finally, using a power stretcher, they stretch the carpet, hooking it to the tackless strip to hold it in place. The installer then finishes the edges using a wall trimmer.

Because most carpet comes in 12-foot widths, wall-to-wall installations require installers to tape or sew sections together for large rooms. They join the seams by sewing them with a large needle and special thread or by using heat-taped seams—a special plastic tape made to join seams when activated by heat.

On special upholstery work, such as stairs, carpet may be held in place with staples. Also, in commercial installations, carpet often is glued directly to the floor or to padding that has been glued to the floor.

Carpet installers use handtools such as hammers, drills, staple guns, carpet knives, and rubber mallets. They also may use carpet-laying tools, such as carpet shears, knee kickers, wall trimmers, loop pile cutters, heat irons, and power stretchers.

Floor installers, or floor layers, apply blocks, strips, or sheets of shock-absorbing, sound-deadening, or decorative coverings to floors and cabinets using rollers, knives, trowels, sanding machines, and other tools. Some floor covering materials are designed to be purely decorative. Others have more-specialized purposes, such as to deaden sound, to absorb shocks, or to create air-tight environments. Before installing the floor, floor layers inspect the surface to be covered and, if necessary, correct any imperfections in order to start with a smooth, clean foundation. They measure and cut floor covering materials, such as rubber, vinyl, linoleum, or cork, and any foundation material, such as felt, according to designated blueprints. Next, they may nail or staple a wood underlayment to the surface or may use an adhesive to cement the foundation material to the floor; the foundation helps to deaden sound and prevents the top floor covering from wearing at board joints. Finally, floor layers install the top covering. They join sections of sheet covering by overlapping adjoining edges and cutting through both layers with a knife to form a tight joint.

Floor sanders and finishers scrape and sand wooden floors to smooth surfaces using floor-scrapers and floor-sanding machines. They then inspect the floor for smoothness and remove excess glue from joints using knife or scraper or wood chisel and may sand wood surfaces by hand, using sandpaper. Finally, they apply coats of finish.

Tile installers, tilesetters, and marble setters apply hard tile and marble to floors, walls, ceilings and roof decks. Tile is durable, impervious to water, and easy to clean, making it a popular building material in hospitals, tunnels, lobbies of buildings, bathrooms, and kitchens. To set tile, which generally ranges in size from 1 inch to 12 or more inches square, tilesetters use cement or “mastic,” a very sticky paste. When using cement, tilesetters nail a support of metal mesh to the wall or ceiling to be tiled. They use a trowel to apply a cement mortar—called a “scratch coat”—onto the metal screen, and scratch the surface of the soft mortar with a small tool, similar to a rake. After the scratch coat has dried, tilesetters apply another coat of mortar to level the surface, and then apply mortar to the back of the tile and place it onto the surface.

To set tile in mastic or a cement adhesive, called “thin set,” tilesetters need a flat, solid surface such as drywall, concrete, plaster, or wood. They use a tooth-edged trowel to spread mastic on the surface or apply cement adhesive, and then properly position the tile.

Because tile varies in color, shape, and size, workers sometimes prearrange tiles on a dry floor according to a specified design. This allows workers to examine the pattern and make changes. In order to cover all exposed areas, including corners, and around pipes, tubs, and wash basins, tilesetters cut tiles to fit with a machine saw or a special cutting tool. Once the tile is placed, they gently tap the surface with their trowel handle or a small block of wood to seat the tiles evenly.

When the cement or mastic has set, tilesetters fill the joints with “grout,” which is very fine cement. They then scrape the surface with a rubber-edged device called a grout float or a grouting trowel



Almost half of all carpet, floor, and tile installers and finishers are self-employed.

to dress the joints and remove excess grout. Before the grout sets, they finish the joints with a damp sponge for a uniform appearance. *Tile finishers* help some tilesetters by supplying and mixing construction materials and doing other tasks such as applying grout and cleaning installed tile.

Marble setters cut and set marble slabs in floors and walls of buildings. They trim and cut marble to specified size using a power wet saw, other cutting equipment, or handtools. After setting the marble in place, they polish the marble to high luster using power tools or by hand.

Working Conditions

Carpet, floor, and tile installers and finishers generally work indoors and have regular daytime hours. However, when floor covering installers work in occupied stores or offices, they may work evenings and weekends to avoid disturbing customers or employees. Installers and finishers usually work under better conditions than most other construction workers. By the time workers install carpets, flooring, or tile in a new structure, most construction has been completed and the work area is relatively clean and uncluttered. Installing these materials is labor intensive; workers spend much of their time bending, kneeling, and reaching—activities that require endurance. Carpet installers frequently lift heavy rolls of carpet and may move heavy furniture. Safety regulations may require that they wear kneepads or safety goggles when using certain tools. Carpet and floor layers may be exposed to fumes from various kinds of glue and to fibers of certain types of carpet.

Although workers are subject to cuts from tools or materials, falls from ladders, and strained muscles, the occupation is not as hazardous as some other construction occupations.

Employment

Carpet, floor, and tile installers and finishers held about 167,000 jobs in 2000. Almost half of all carpet, floor, and tile installers and finishers were self-employed, compared with fewer than 1 in 5 of all construction trades workers. The following tabulation shows 2000 employment by specialty.

Carpet installers	76,000
Tile and marble setters	54,000
Floor layers, except carpet, wood, and hard tiles	23,000
Floor sanders and finishers	14,000

Many carpet installers worked for flooring contractors or floor covering retailers. Most salaried tilesetters were employed by tilesetting contractors who work mainly on nonresidential construction projects, such as schools, hospitals, and office buildings. Most self-employed tilesetters work on residential projects.

Although carpet, floor, and tile installers and finishers are employed throughout the Nation, they tend to be concentrated in populated areas where there are high levels of construction activity.

Training, Other Qualifications, and Advancement

The vast majority of carpet, floor, and tile installers and finishers learn their trade informally, on the job, as helpers to experienced workers. Others learn through formal apprenticeship programs, which include on-the-job training as well as related classroom instruction.

Informal training for carpet installers often is sponsored by individual contractors, and generally lasts from about 1-1/2 to 2 years. Workers start as helpers, and begin with simple assignments, such as installing stripping and padding, or helping to stretch newly installed carpet. With experience, helpers take on more difficult assignments, such as measuring, cutting, and fitting.

Persons who wish to begin a career in carpet installation as a helper or apprentice should be at least 18 years old and have good manual dexterity. Many employers prefer applicants with a high school diploma; courses in general mathematics and shop are helpful. Some employers may require a driver's license and a criminal background check. Because carpet installers frequently deal directly with customers, they should be courteous and tactful.

Many tile and floor layers learn their job through on-the-job training and begin by learning about the tools of the trade. They next learn to prepare surfaces to receive flooring. As they progress, tilesetters, marble setters, and resilient floor layers learn to cut and install tile, marble, and floor coverings. Tile and marble setters also learn to apply grout and to do finishing work.

Apprenticeship programs and some contractor-sponsored programs provide comprehensive training in all phases of the tilesetting and floor layer trade. Most apprenticeship programs are union-sponsored and consist of weekly classes and on-the-job training usually lasting 3 to 4 years.

When hiring apprentices or helpers for floor layer and tilesetter jobs, employers usually prefer high school graduates who have had courses in general mathematics, mechanical drawing, and shop. Good physical condition, manual dexterity, and a good sense of color harmony also are important assets.

Carpet, floor, and tile installers and finishers may advance to positions as supervisors or become salespersons or estimators. Some carpet installers may become managers for large installation firms. Many carpet, floor, and tile installers and finishers who begin working for a large contractor eventually go into business for themselves as independent subcontractors.

Job Outlook

Employment of carpet, floor, and tile installers and finishers is expected to grow about as fast as the average for all occupations through the year 2010. Employment growth stems primarily from the continued need to renovate and refurbish existing structures. Carpet installers, the largest specialty, should have the best job opportunities.

Carpet as a floor covering continues to be popular and its use is expected to grow in structures such as schools, offices, hospitals, and industrial plants. Demand for carpet also will be stimulated by new, more durable fibers that are stain and crush resistant, and come in a wider variety of colors. More resilient carpet needs to be replaced less often, but these attractive new products may induce more people to replace their old carpeting, contributing further to the demand for carpet installers. Employment also is expected to grow because wall-to-wall carpeting is a necessity in the many houses built with plywood, rather than hardwood floors. Similarly, offices, hotels, and stores often cover concrete floors with wall-to-wall carpet, which must be periodically replaced.

Demand for tile and marble setters will stem from population and business growth, which should result in more construction of shopping malls, hospitals, schools, restaurants, and other structures in which tile is used extensively. Tile is expected to continue to increase in popularity as a building material and to be used more extensively, particularly in more expensive homes, whose construction is expected to increase. In more modestly priced homes, however, the use of tile substitutes, such as plastic or fiberglass tub and shower enclosures, is expected to increase, slowing the growth in demand for tile and marble setters. Demand for floor layers and sanders and finishers will increase as a result of an increase in construction activity, particularly of residential homes and commercial buildings, and as some people decide to replace their plywood floors with hardwood floors. Job opportunities for tile and marble setters and floor layers and sanders, relatively small specialties, will not be as plentiful as those for carpet installers.

Carpet, floor, and tile installers and finishers are less sensitive to changes in construction activity than are most other construction occupations because much of their work involves replacing carpet and other flooring in existing buildings. As a result these workers tend to be sheltered from the business fluctuations that often occur in new construction activity.

Earnings

In 2000, the median hourly earnings of carpet installers were \$14.46. The middle 50 percent earned between \$10.41 and \$20.47. The lowest 10 percent earned less than \$7.97, and the top 10 percent earned more than \$26.22. Median hourly earnings of carpet installers in 2000 in carpentry and floor work were \$15.25 and in furniture and home furnishings stores, \$13.31.

Carpet installers are paid either on an hourly basis, or by the number of yards of carpet installed. The rates vary widely depending on the geographic location and whether the installer is affiliated with a union.

Median hourly earnings of floor layers were \$14.81 in 2000. The middle 50 percent earned between \$10.53 and \$20.21. The lowest 10 percent earned less than \$8.06, and the top 10 percent earned more than \$26.01.

Median hourly earnings of floor sanders and finishers were \$13.17 in 2000. The middle 50 percent earned between \$10.51 and \$17.80. The lowest 10 percent earned less than \$8.75, and the top 10 percent earned more than \$24.72.

Median hourly earnings of tile- and marble setters were \$16.49 in 2000. The middle 50 percent earned between \$12.54 and \$21.93. The lowest 10 percent earned less than \$9.58, and the top 10 percent

earned more than \$26.61. Earnings of tile- and marble setters also vary greatly by geographic location and by union membership.

Apprentices and other trainees usually start out earning about half of what an experienced worker earns, although their wage rate increases as they advance through the training program.

Some carpet, floor, and tile installers and finishers belong to the United Brotherhood of Carpenters and Joiners of America. Some tilesetters also belong to the International Union of Bricklayers and Allied Craftsmen, while some carpet installers belong to the International Brotherhood of Painters and Allied Trades.

Related Occupations

Carpet, floor, and tile installers and finishers measure, cut, and fit materials to cover a space. Workers in other occupations involving similar skills, but using different materials, include brickmasons, blockmasons, and stonemasons; carpenters; cement masons, concrete finishers, segmental pavers, and terrazzo workers; drywall installers, ceiling tile installers, and tapers; painters and paperhangers; roofers; and sheet metal workers.

Sources of Additional Information

For details about apprenticeships or work opportunities, contact local flooring or tilesetting contractors or retailers, locals of the unions previously mentioned, or the nearest office of the State apprenticeship agency or employment service.

For general information about the work of carpet installers and floor layers, contact:

► Floor Covering Installation Contractors Association, 7439 Milwood Dr., West Bloomfield, MI 48322.

Additional information on training for carpet installers and floor layers is available from:

► International Union of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006. Internet: <http://www.iupat.org>

For general information about the work of tilesetters and finishers, contact:

► International Union of Bricklayers and Allied Crafts Workers, International Masonry Institute, Apprenticeship and Training, 815 15th St. NW., Washington, DC 20005. Internet: <http://www.bacweb.org>

► National Association of Home Builders, 1201 15th St. NW., Washington, DC 20005. Internet: <http://www.nahb.com>

For information concerning training of carpet, floor, and tile installers and finishers contact:

► United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, DC 20001. Internet: <http://necarpenters.org/ubc.htm>

Cement Masons, Concrete Finishers, Segmental Pavers, and Terrazzo Workers

(O*NET 47-2051.00, 47-2053.00, 47-4091.00)

Significant Points

- Job opportunities are expected to be excellent.
- Most learn on the job, either through formal 3-year apprenticeship programs or by working as helpers.
- Like many other construction trades workers, layoffs may occur during downturns in construction activity.

Nature of the Work

Cement masons, concrete finishers, and terrazzo workers all work with concrete, one of the most common and durable materials used

in construction. Once set, concrete—a mixture of Portland cement, sand, gravel, and water—becomes the foundation for everything from decorative patios and floors to huge dams or miles of roadways.

Cement masons and *concrete finishers* place and finish the concrete. They also may color concrete surfaces; expose aggregate (small stones) in walls and sidewalks; or fabricate concrete beams, columns, and panels. In preparing a site for placing concrete, cement masons first set the forms for holding the concrete and properly align them. They then direct the casting of the concrete and supervise laborers who use shovels or special tools to spread it. Masons then guide a straightedge back and forth across the top of the forms to “screed,” or level, the freshly placed concrete. Immediately after leveling the concrete, masons carefully smooth the concrete surface with a “bull float,” a long-handled tool about 8 by 48 inches that covers the coarser materials in the concrete and brings a rich mixture of fine cement paste to the surface.

After the concrete has been leveled and floated, concrete finishers press an edger between the forms and the concrete and guide it along the edge and the surface. This produces slightly rounded edges and helps prevent chipping or cracking. They use a special tool called a “groover” to make joints or grooves at specific intervals that help control cracking. Next, finishers trowel the surface using either a powered or hand trowel, a small, smooth, rectangular metal tool.

Sometimes, cement masons perform all the steps of laying concrete, including the finishing. As the final step, masons retrowel the concrete surface back and forth with powered and hand trowels to create a smooth finish. For a coarse, nonskid finish, masons brush the surface with a broom or stiff-bristled brush. For a pebble finish, they embed small gravel chips into the surface. They then wash any excess cement from the exposed chips with a mild acid solution. For color, they use colored premixed concrete. On concrete surfaces that will remain exposed after the forms are stripped, such as columns, ceilings, and wall panels, cement masons cut away high spots and loose concrete with hammer and chisel, fill any large indentations with a Portland cement paste, and smooth the surface with a carborundum stone. Finally, they coat the exposed area with a rich Portland cement mixture, using either a special tool or a coarse cloth to rub the concrete to a uniform finish.

Throughout the entire process, cement masons must monitor how the wind, heat, or cold affects the curing of the concrete. They must have a thorough knowledge of concrete characteristics so that, by using sight and touch, they can determine what is happening to the concrete and take measures to prevent defects.

Segmental pavers lay out, cut, and install pavers, which are flat pieces of masonry usually made from compacted concrete or brick. Pavers are used to pave paths, patios, playgrounds, driveways, and steps. They are manufactured in various textures and often interlock together to form an attractive pattern. Segmental pavers first prepare the site by removing the existing pavement or existing soil. They grade the soil to the proper depth and determine the amount of base material that is needed, which depends on the local soil conditions. They then install and compact the base material, a granular material that compacts easily, and lay the pavers from the center out, so that any trimmed pieces will be on the outside rather than in the center. Then they install edging materials to prevent the pavers from shifting and fill the spaces between the pavers with dry sand.

Terrazzo workers create attractive walkways, floors, patios, and panels by exposing marble chips and other fine aggregates on the surface of finished concrete. Much of the preliminary work of terrazzo workers is similar to that of cement masons. Attractive, marble-chip terrazzo requires three layers of materials. First, cement masons or terrazzo workers build a solid, level concrete foundation



Concrete finishers use hand trowels to smooth the surface.

that is 3 to 4 inches deep. After the forms are removed from the foundation, workers add a 1-inch layer of sandy concrete. Before this layer sets, terrazzo workers partially embed metal divider strips in the concrete wherever there is to be a joint or change of color in the terrazzo. For the final layer, terrazzo workers blend and place into each of the panels a fine marble chip mixture that may be color-pigmented. While the mixture is still wet, workers toss additional marble chips of various colors into each panel and roll a lightweight roller over the entire surface.

When the terrazzo is thoroughly dry, helpers grind it with a terrazzo grinder, which is somewhat like a floor polisher, only much heavier. Slight depressions left by the grinding are filled with a matching grout material and hand-troweled for a smooth, uniform surface. Terrazzo workers then clean, polish, and seal the dry surface for a lustrous finish.

Working Conditions

Concrete, segmental paving, or terrazzo work is fast-paced and strenuous, and requires continuous physical effort. Because most finishing is done at floor level, workers must bend and kneel often. Many jobs are outdoors, and work is generally halted during inclement weather. The work, either indoors or outdoors, may be in areas that are muddy, dusty, and dirty. To avoid chemical burns from uncured concrete and sore knees from frequent kneeling, many workers wear kneepads. Workers also usually wear water-repellent boots while working in wet concrete.

Employment

Cement masons, concrete finishers, segmental pavers, and terrazzo workers held about 166,000 jobs in 2000; segmental pavers and terrazzo workers accounted for only a small portion of the total. Most cement masons and concrete finishers worked for concrete contractors or for general contractors on projects such as highways; bridges; shopping malls; or large buildings such as factories, schools, and hospitals. A small number were employed by firms that manufacture concrete products. Most segmental pavers and terrazzo workers worked for special trade contractors who install decorative floors and wall panels.

Only about 1 out of 20 cement masons, concrete finishers, segmental pavers, and terrazzo workers were self-employed, a smaller proportion than in other building trades. Most self-employed masons specialized in small jobs, such as driveways, sidewalks, and patios.

Training, Other Qualifications, and Advancement

Most cement masons, concrete finishers, segmental pavers, and terrazzo workers learn their trades either through on-the-job training as helpers, or through 3-year apprenticeship programs. Many masons and finishers first gain experience as construction laborers. (See the statement on construction laborers elsewhere in the *Handbook*.)

When hiring helpers and apprentices, employers prefer high school graduates who are at least 18 years old and in good physical condition, and who have a driver's license. The ability to get along with others also is important because cement masons frequently work in teams. High school courses in general science, shop, mathematics, blueprint reading, or mechanical drawing provide a helpful background.

On-the-job training programs consist of informal instruction, in which experienced workers teach helpers to use the tools, equipment, machines, and materials of the trade. They begin with tasks such as edging, jointing and using a straightedge on freshly placed concrete. As training progresses, assignments become more complex, and trainees can usually do finishing work within a short time.

Three-year apprenticeship programs, usually jointly sponsored by local unions and contractors, provide on-the-job training in addition to a recommended minimum of 144 hours of classroom instruction each year. A written test and a physical exam may be required. In the classroom, apprentices learn applied mathematics, blueprint reading, and safety. Apprentices generally receive special instruction in layout work and cost estimation. Some workers learn their jobs by attending trade or vocational/technical schools.

Cement masons, concrete finishers, segmental pavers, and terrazzo workers should enjoy doing demanding work. They should take pride in craftsmanship and be able to work without close supervision.

Experienced cement masons, concrete finishers, segmental pavers, or terrazzo workers may advance to become supervisors or contract estimators. Some open their own concrete businesses.

Job Outlook

Despite expected slow job growth, opportunities for skilled cement masons, concrete finishers, segmental pavers, and terrazzo workers are expected to be excellent as the increase in demand outpaces the supply of workers trained in this craft. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment of cement masons, concrete finishers, segmental pavers, and terrazzo workers is expected to grow more slowly than the average for all occupations through 2010. These workers will be needed to build highways, bridges, subways, factories, office buildings, hotels, shopping centers, schools, hospitals, and other structures. In addition, the increasing use of concrete as a building material—particularly in nonresidential construction—will add to the demand. More cement masons also will be needed to repair and renovate existing highways, bridges, and other structures.

Employment growth, however, will not keep pace with the growth of these construction projects. Worker productivity will be increased through use of improved concrete pumping systems, continuous concrete mixers, quicker-setting cement, troweling machines, pre-fabricated masonry systems, and other improved materials, equipment, and tools. In addition to job growth, other openings will become available as experienced workers transfer to other occupations or leave the labor force.

Employment of cement masons, concrete finishers, segmental pavers, and terrazzo workers, like that of many other workers, is sensitive to the fluctuations of the economy. Workers in these trades

may experience periods of unemployment when the level of non-residential construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Earnings

In 2000, the median hourly earnings of cement masons and concrete finishers were \$13.50. The middle 50 percent earned between \$10.55 and \$18.41. The top 10 percent earned over \$24.22, and the bottom 10 percent earned less than \$8.31. Median hourly earnings in the industries employing the largest numbers of cement masons and concrete finishers in 2000 are shown below:

Masonry, stonework, and plastering	\$15.48
Highway and street construction	14.88
Concrete work	13.90
Nonresidential building construction	13.80
Residential building construction	11.31

In 2000, the median hourly earnings of terrazzo workers and finishers were \$15.06 and median annual earnings of segmental pavers were \$12.46.

Like those of other construction trades workers, earnings of cement masons, concrete finishers, segmental pavers, and terrazzo workers may be reduced on occasion because poor weather and downturns in construction activity limit the time they can work. Cement masons often work overtime, with premium pay, because once concrete has been placed, the job must be completed.

Many cement masons, concrete finishers, segmental pavers, and terrazzo workers belong to the Operative Plasterers' and Cement Masons' International Association of the United States and Canada, or to the International Union of Bricklayers and Allied Craftworkers. Some terrazzo workers belong to the United Brotherhood of Carpenters and Joiners of the United States. Nonunion workers generally have lower wage rates than union workers. Apprentices usually start at 50 to 60 percent of the rate paid to experienced workers.

Related Occupations

Cement masons, concrete finishers, segmental pavers, and terrazzo workers combine skill with knowledge of building materials to construct buildings, highways, and other structures. Other occupations involving similar skills and knowledge include brickmasons, blockmasons, and stonemasons; carpet, floor, and tile installers and finishers; drywall installers, ceiling tile installers, and tapers; and plasterers and stucco masons.

Sources of Additional Information

For information about apprenticeships and work opportunities, contact local concrete or terrazzo contractors, locals of unions previously mentioned, a local joint union-management apprenticeship committee, or the nearest office of the State employment service or apprenticeship agency.

For general information about cement masons, concrete finishers, segmental pavers, and terrazzo workers, contact:

- Associated General Contractors of America, Inc., 1957 E St. NW., Washington, DC 20006. Internet: <http://www.agc.org>
- International Union of Bricklayers and Allied Craftworkers, International Masonry Institute, 815 15th St. NW., Suite 1001, Washington, DC 20005. Internet: <http://www.bacweb.org>
- Operative Plasterers' and Cement Masons' International Association of the United States and Canada, 14405 Laurel Place, Suite 300, Laurel, MD 20707. Internet: <http://www.concrete-plaster.com>
- National Terrazzo and Mosaic Association, 101 E. Market St., Suite 200 A, Leesburg, VA 20176-3122. Internet: <http://www.ntma.com>

- Portland Cement Association, 5420 Old Orchard Rd., Skokie, IL 60077. Internet: <http://www.portcement.org/index.asp>
- United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, DC 20001.

Construction and Building Inspectors

(O*NET 47-4011.00)

Significant Points

- About half of all inspectors worked for local governments, primarily municipal or county building departments.
- Opportunities should be best for experienced construction supervisors and craftworkers who have some college education, engineering or architectural training, or certification as construction inspectors or plan examiners.

Nature of the Work

Construction and building inspectors examine the construction, alteration, or repair of buildings, highways and streets, sewer and water systems, dams, bridges, and other structures to ensure compliance with building codes and ordinances, zoning regulations, and contract specifications. Building codes and standards are the primary means by which building construction is regulated in the United States to assure the health and safety of the general public. Inspectors make an initial inspection during the first phase of construction, and follow-up inspections throughout the construction project to monitor compliance with regulations. However, no inspection is ever exactly the same. In areas where certain types of severe weather or natural disasters are more common, inspectors monitor compliance with additional safety regulations designed to protect structures and occupants during these events.

Building inspectors inspect the structural quality and general safety of buildings. Some specialize in such areas as structural steel or reinforced concrete structures. Before construction begins, *plan examiners* determine whether the plans for the building or other structure comply with building code regulations and if they are suited to the engineering and environmental demands of the building site. Inspectors visit the worksite before the foundation is poured to inspect the soil condition and positioning and depth of the footings. Later, they return to the site to inspect the foundation after it has been completed. The size and type of structure, as well as the rate of completion, determine the number of other site visits they must make. Upon completion of the project, they make a final comprehensive inspection.

In addition to structural characteristics, a primary concern of building inspectors is fire safety. They inspect structures' fire sprinklers, alarms, and smoke control systems, as well as fire exits. Inspectors assess the type of construction, building contents, adequacy of fire protection equipment, and risks posed by adjoining buildings.

In the past, most localities based their building codes on regional model codes established by the Building Officials and Code Administration (BOCA), the International Conference of Building Officials (ICBO), or the Southern Building Code Congress International (SBCCI). Therefore, building inspectors in one region who were experts in one code found it difficult to move to an area of the country using another code. To eliminate differences among the three sets of codes, these organizations jointly created the International Code Council (ICC), which released the Nation's first set of

uniform building code regulations. This makes it much easier for construction and building inspectors to move to different regions within the United States.

There are many types of inspectors. *Electrical inspectors* examine the installation of electrical systems and equipment to ensure that they function properly and comply with electrical codes and standards. They visit worksites to inspect new and existing sound and security systems, wiring, lighting, motors, and generating equipment. They also inspect the installation of the electrical wiring for heating and air-conditioning systems, appliances, and other components.

Elevator inspectors examine lifting and conveying devices such as elevators, escalators, moving sidewalks, lifts and hoists, inclined railways, ski lifts, and amusement rides.

Mechanical inspectors inspect the installation of the mechanical components of commercial kitchen appliances, heating and air-conditioning equipment, gasoline and butane tanks, gas and oil piping, and gas-fired and oil-fired appliances. Some specialize in boilers or ventilating equipment as well.

Plumbing inspectors examine plumbing systems, including private disposal systems, water supply and distribution systems, plumbing fixtures and traps, and drain, waste, and vent lines.

Public works inspectors ensure that Federal, State, and local government construction of water and sewer systems, highways, streets, bridges, and dams conforms to detailed contract specifications. They inspect excavation and fill operations, the placement of forms for concrete, concrete mixing and pouring, asphalt paving, and grading operations. They record the work and materials used so that contract payments can be calculated. Public works inspectors may specialize in highways, structural steel, reinforced concrete, or ditches. Others specialize in dredging operations required for bridges and dams or for harbors.

Home inspectors generally conduct inspections of newly built or previously owned homes. Increasingly, prospective home buyers hire home inspectors to inspect and report the condition of a home's systems, components, and structure. They typically are hired either immediately prior to a purchase offer on a home, or as a contingency to a sales contract. In addition to structural quality, home inspectors must be able to inspect all home systems and features, from plumbing, electrical, and heating or cooling systems to roofing.

The owner of a building or structure under construction employs *specification inspectors* to ensure that work is done according to design specifications. They represent the owner's interests, not those of the general public. Insurance companies and financial institutions also may use specification inspectors.

Details concerning construction projects, building and occupancy permits, and other documentation generally are stored on computers so that they can easily be retrieved, kept accurate, and updated. For example, inspectors may use laptop computers to record their findings while inspecting a site. Most inspectors use computers to help them monitor the status of construction inspection activities and keep track of issued permits.

Although inspections are primarily visual, inspectors may use tape measures, survey instruments, metering devices, and test equipment such as concrete strength measurers. They keep a log of their work, take photographs, file reports, and, if necessary, act on their findings. For example, construction inspectors notify the construction contractor, superintendent, or supervisor when they discover a code or ordinance violation or something that does not comply with the contract specifications or approved plans. If the problem is not corrected within a reasonable or specified period, government inspectors have authority to issue a "stop-work" order.

Many inspectors also investigate construction or alterations being done without proper permits. Inspectors who are employees of municipalities enforce laws pertaining to the proper design, construction,



Some construction and building inspectors check for compliance with electrical codes.

and use of buildings. They direct violators of permit laws to obtain permits and submit to inspection.

Working Conditions

Construction and building inspectors usually work alone. However, several may be assigned to large, complex projects, particularly because inspectors tend to specialize in different areas of construction. Though they spend considerable time inspecting construction worksites, inspectors also spend time in a field office reviewing blueprints, answering letters or telephone calls, writing reports, and scheduling inspections.

Inspection sites are dirty and may be cluttered with tools, materials, or debris. Inspectors may have to climb ladders or many flights of stairs, or crawl around in tight spaces. Although their work generally is not considered hazardous, inspectors, like other construction workers, wear hard hats and adhere to other safety requirements while at a construction site.

Inspectors normally work regular hours. However, they may work additional hours during periods when a lot of construction is taking place. Also, if an accident occurs at a construction site, inspectors must respond immediately and may work additional hours to complete their report.

Employment

Construction and building inspectors held about 75,000 jobs in 2000. Local governments, primarily municipal or county building departments, employed 49 percent. Employment of local government inspectors is concentrated in cities and in suburban areas undergoing rapid growth. Local governments employ large inspection staffs, including many plan examiners or inspectors who specialize in structural steel, reinforced concrete, boiler, electrical, and elevator inspection.

Another 17 percent of construction and building inspectors worked for engineering and architectural services firms, conducting inspections for a fee or on a contract basis. Many of these are home inspectors working on the behalf of potential real estate purchasers. Most of the remaining inspectors were employed in other services industries or by State governments.

Training, Other Qualifications, and Advancement

Although requirements vary considerably depending upon where one is employed, individuals who want to become construction and building inspectors should have a thorough knowledge of construction materials and practices in either a general area, such as

structural or heavy construction, or in a specialized area, such as electrical or plumbing systems, reinforced concrete, or structural steel. Applicants for construction or building inspection jobs need several years of experience as a construction manager, supervisor, or craftworker. Many inspectors previously worked as carpenters, electricians, plumbers, or pipefitters.

Because inspectors must possess the right mix of technical knowledge, experience, and education, employers prefer applicants who have formal training as well as experience. Most employers require at least a high school diploma or equivalent, even for workers with considerable experience. More often, employers look for persons who have studied engineering or architecture, or who have a degree from a community or junior college, with courses in building inspection, home inspection, construction technology, drafting, and mathematics. Many community colleges offer certificate or associate degree programs in building inspection technology. Courses in blueprint reading, algebra, geometry, and English also are useful.

Construction and building inspectors must be in good physical condition in order to walk and climb about construction sites. They must also have a driver's license. In addition, Federal, State, and many local governments may require that inspectors pass a civil service exam.

Construction and building inspectors usually receive much of their training on the job, although they must learn building codes and standards on their own. Working with an experienced inspector, they learn about inspection techniques; codes, ordinances, and regulations; contract specifications; and recordkeeping and reporting duties. They may begin by inspecting less complex types of construction, such as residential buildings, and then progress to more difficult assignments. An engineering or architectural degree is often required for advancement to supervisory positions.

Because they advise builders and the general public on building codes, construction practices, and technical developments, construction and building inspectors must keep abreast of changes in these areas. Continuing education is imperative in this field. Many employers provide formal training programs to broaden inspectors' knowledge of construction materials, practices, and techniques. Inspectors who work for small agencies or firms that do not conduct training programs can expand their knowledge and upgrade their skills by attending State-sponsored training programs, by taking college or correspondence courses, or by attending seminars sponsored by various related organizations, such as model code organizations.

Most States and cities require some type of certification for employment; even if not required, certification can enhance an inspector's opportunities for employment and advancement to more responsible positions. To become certified, inspectors with substantial experience and education must pass stringent examinations on code requirements, construction techniques, and materials. The three major model code organizations offer voluntary certification, as do other professional membership associations. In most cases, there are no education or experience prerequisites, and certification consists of passing an examination in a designated field. Many categories of certification are awarded for inspectors and plan examiners in a variety of disciplines, including the designation "CBO," Certified Building Official, offered by the International Code Council.

Job Outlook

Employment of construction and building inspectors is expected to grow as fast as the average for all occupations through 2010. Growing concern for public safety and improvements in the quality of construction should continue to stimulate demand for construction and building inspectors. In addition to the expected employment growth, some job openings will arise from the need to replace inspectors who transfer to other occupations or leave the labor force. Well-trained workers will have especially favorable opportunities.

Opportunities should be best for highly experienced supervisors and craftworkers who have some college education, engineering or architectural training, or certification as inspectors or plan examiners. Thorough knowledge of construction practices and skills in areas such as reading and evaluating blueprints and plans are essential.

Inspectors are involved in all phases of construction, including maintenance and repair work, and are therefore less likely to lose jobs when new construction slows during recessions. As the population grows and the volume of real estate transactions increases, greater emphasis on home inspections should result in rapid growth in employment of home inspectors. In addition, there should be good opportunities in engineering, architectural, and management services firms due to the tendency of governments—particularly Federal and State—to contract out inspection work, and due to expected growth in private inspection services.

Earnings

Median annual earnings of construction and building inspectors were \$38,750 in 2000. The middle 50 percent earned between \$30,640 and \$47,860. The lowest 10 percent earned less than \$24,370, and the highest 10 percent earned more than \$56,570. Median annual earnings in the industries employing the largest numbers of construction and building inspectors in 2000 were:

Local government	\$39,410
State government	38,370
Engineering and architectural services	37,810

Generally, building inspectors, including plan examiners, earn the highest salaries. Salaries in large metropolitan areas are substantially higher than those in small local jurisdictions.

Related Occupations

Construction and building inspectors combine knowledge of construction principles and law with an ability to coordinate data, diagnose problems, and communicate with people. Workers in other occupations using a similar combination of skills include architects, except landscape and naval; construction managers; civil engineers; cost estimators; drafters; engineering technicians; and surveyors, cartographers, photogrammetrists, and surveying technicians.

Sources of Additional Information

Information about certification and a career as a construction or building inspector is available from the following model code organizations:

- ▶ International Conference of Building Officials, 5360 Workman Mill Rd., Whittier, CA 90601-2298. Internet: <http://www.icbo.org>
- ▶ Building Officials and Code Administrators International, Inc., 4051 West Flossmoor Rd., Country Club Hills, IL 60478. Internet: <http://www.bocai.org>
- ▶ Southern Building Code Congress International, Inc., 900 Montclair Rd., Birmingham, AL 35213. Internet: <http://sbcci.org>

Information about training for construction inspectors is available from:

- ▶ Association of Construction Inspectors, 1224 North Nokomis NE., Alexandria, MN 56308. Internet: <http://www.iami.org>

General information about electrical inspection is available from:

- ▶ International Association of Electrical Inspectors, 901 Waterfall Way, Suite 602, Richardson, TX 75080. Internet: <http://www.iaei.com>

Information about a career as a home inspector is available from:

- ▶ American Society of Home Inspectors, Inc., 932 Lee St., Suite 101, Des Plaines, IL 60016. Internet: <http://www.ashi.com>

For information about a career as a State or local government construction or building inspector, contact your State or local employment service.

Construction Equipment Operators

(O*NET 47-2071.00, 47-2072.00, 47-2073.01, 47-2073.02)

Significant Points

- Most construction equipment operators acquire their skills on the job, but formal apprenticeship programs provide more comprehensive training.
- Job opportunities are expected to be good, despite slower-than-average employment growth.
- Hourly pay is relatively high but, because construction equipment operators cannot work in inclement weather, total earnings may be reduced.

Nature of the Work

Construction equipment operators use machinery to move construction materials, earth, and other heavy materials and to apply asphalt and concrete to roads and other structures. Operators control equipment by moving levers or foot pedals, operating switches, or turning dials. The operation of much of this equipment is becoming more complex as a result of computerized controls. Construction equipment operators may also set up and inspect equipment, make adjustments, and perform minor repairs.

Construction equipment operators include operating engineers and other construction equipment operators; paving, surfacing, and tamping equipment operators; and pile driver operators. *Operating engineers and other construction equipment operators* operate one or several types of power construction equipment. They may operate excavation and loading machines equipped with scoops, shovels, or buckets that dig sand, gravel, earth, or similar materials and load it into trucks or onto conveyors. In addition to the familiar bulldozers, they operate trench excavators, road graders, and similar equipment. Sometimes, they may drive and control industrial trucks or tractors equipped with a fork-lift or boom for lifting materials, or hitches for pulling trailers. They also may operate and maintain air compressors, pumps, and other power equipment at construction sites. Construction equipment operators who are classified as operating engineers have the capability of operating several different types of construction equipment.

Paving and surfacing equipment operators use levers and other controls to operate machines that spread and level asphalt or spread and smooth concrete for roadways or other structures. *Asphalt paving machine operators* turn valves to regulate the temperature and flow of asphalt onto the roadbed. They must take care that the machine distributes the paving material evenly and without voids, and make sure that there is a constant flow of asphalt going into the hopper. *Concrete paving machine operators* move levers and turn handwheels to lower an attachment that spreads, vibrates, and levels wet concrete within forms. They must observe the surface of concrete to identify low spots into which workers must add concrete. They use other attachments to the machine to smooth the surface of the concrete, spray on a curing compound, and cut expansion joints. *Tamping equipment operators* operate tamping machines that compact earth and other fill materials for roadbeds. They also may operate machines with interchangeable hammers to cut or break up old pavement and drive guardrail posts into the earth.

Pile driver operators operate pile drivers—large machines mounted on skids, barges, or cranes, which hammer piles into the ground. Piles are long heavy beams of wood or steel that are driven



Air hammer operators use machines with interchangeable hammers to cut or break up old pavement.

into the ground to support retaining walls, bulkheads, bridges, piers, or building foundations. Some pile driver operators work on off-shore oil rigs. Pile driver operators move hand and foot levers and turn valves to activate, position, and control the pile-driving equipment.

Working Conditions

Many construction equipment operators work outdoors, in nearly every type of climate and weather condition. Some machines, including bulldozers, scrapers, and especially tampers and pile drivers, are noisy and shake or jolt the operator. Operating heavy construction equipment can be dangerous. As with most machinery, accidents generally can be avoided by observing proper operating procedures and safety practices. Construction equipment operators can expect to be cold in the winter and hot in the summer, and often get dirty, greasy, muddy, or dusty.

Operators may have irregular hours because work on some construction projects continues around the clock. Some operators work in remote locations on large construction projects, such as highways and dams, or in factory or mining operations.

Employment

Construction equipment operators held about 416,000 jobs in 2000. Jobs were found in every section of the country and were distributed among various types of operators as follows:

Operating engineers and other construction equipment operators	357,000
Paving, surfacing, and tamping equipment operators	55,000
Pile-driver operators	4,400

About 3 out of every 5 construction equipment operators worked in the construction industry. Many equipment operators worked in heavy construction, building highways, bridges, or railroads. About 81,000 of all construction equipment operators worked in State and local government. Others—mostly grader, bulldozer, and scraper operators—worked in mining. Some also worked in manufacturing and for utility companies. About 1 in 20 construction equipment operators were self-employed.

Training, Other Qualifications, and Advancement

Construction equipment operators usually learn their skills on the job. However, it is generally accepted that formal training provides more comprehensive skills. Some construction equipment operators train in formal 3-year operating engineer apprenticeship programs administered by union-management committees of the International Union of Operating Engineers and the Associated General Contractors of America. Because apprentices learn to operate a wider variety of machines than do other beginners, they usually have better job opportunities. Apprenticeship programs consist of at least 3 years, or 6,000 hours, of on-the-job training and 144 hours a year of related classroom instruction.

Employers of construction equipment operators generally prefer to hire high school graduates, although some employers may train persons having less education to operate some types of equipment. The more technologically advanced construction equipment has computerized controls and improved hydraulics and electronics, requiring more skill to operate than previously was necessary. Operators of such equipment may need more training and some understanding of electronics. Mechanical aptitude and high school training in automobile mechanics are helpful because workers may perform some maintenance on their machines. Also, high school courses in science and mechanical drawing are useful. Experience operating related mobile equipment, such as farm tractors or heavy equipment, in the Armed Forces or elsewhere is an asset.

Private vocational schools offer instruction in the operation of certain types of construction equipment. Completion of such a program may help a person get a job as a trainee or apprentice. However, persons considering such training should check the reputation of the school among employers in the area.

Beginning construction equipment operators handle light equipment under the guidance of an experienced operator. Later, they may operate heavier equipment such as bulldozers and cranes. Operators need to be in good physical condition and have a good sense of balance, the ability to judge distance, and eye-hand-foot coordination. Some operator positions require the ability to work at heights.

Job Outlook

Job opportunities for construction equipment operators are expected to be good through 2010—due, in part, to the shortage of adequate training programs. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment of construction equipment operators is expected to increase more slowly than the average for all occupations through the year 2010 because equipment improvements are expected to continue to raise worker productivity and to moderate demand for skilled construction equipment operators. Employment is expected to increase as population and business growth create a need for new

houses, industrial facilities, schools, hospitals, offices, and other structures. Also stimulating demand is the expected growth in highway, bridge, and street construction. Bridge construction is expected to grow the fastest, due to the need to repair or replace structures before they become unsafe. Poor highway conditions also will spur demand for highway maintenance and repair. In the last several years, Congress has passed substantial public works bills designed to provide money for such construction projects, including mass transit systems. In addition to employment growth in this occupation, many job openings will arise because of the need to replace experienced workers who transfer to other occupations or leave the labor force.

Employment of construction equipment operators is sensitive to fluctuations in the economy. Workers may experience periods of unemployment when the level of construction activity falls.

Earnings

Earnings for construction equipment operators vary. In 2000, median hourly earnings of operating engineers and other construction equipment operators were \$15.99. The middle 50 percent earned between \$12.21 and \$21.68. The lowest 10 percent earned less than \$10.00, and the highest 10 percent earned more than \$27.29. Median hourly earnings in the industries employing the largest numbers of operating engineers in 2000 were:

Highway and street construction	\$18.68
Miscellaneous special trade contractors	16.68
Heavy construction, except highway	16.63
Local government	13.95
State government	12.83

Median hourly earnings of paving, surfacing, and tamping equipment operators were \$12.88 in 2000. The middle 50 percent earned between \$10.04 and \$17.57. The lowest 10 percent earned less than \$8.51, and the highest 10 percent earned more than \$23.57. Median hourly earnings in the industries employing the largest numbers of paving, surfacing, and tamping equipment operators in 2000 were:

Highway and street construction	\$13.45
Concrete work	12.91
Local government	12.57

In 2000, median hourly earnings of pile driver operators were \$19.85. The middle 50 percent earned between \$13.36 and \$26.03. The lowest 10 percent earned less than \$10.99, and the highest 10 percent earned more than \$31.04.

Pay scales generally are higher in metropolitan areas. Annual earnings of some workers may be lower than hourly rates would indicate because worktime may be limited by bad weather.

Related Occupations

Other workers who operate heavy mechanical equipment include bus drivers; truck drivers and driver/sales workers; farmers, ranchers, and agricultural managers; agricultural workers; and forest, conservation, and logging workers.

Sources of Additional Information

For further information about apprenticeships or work opportunities for construction equipment operators, contact a local of the International Union of Operating Engineers, a local apprenticeship committee, or the nearest office of the State apprenticeship agency or employment service. For general information about the work of construction equipment operators, contact:

► National Center for Construction Education and Research, University of Florida, P.O. Box 141104, Gainesville, FL 32614-1104. Internet: <http://www.nccer.org>

- Associated General Contractors of America, 333 John Carlyle St., Suite 200, Alexandria, VA 22314. Internet: <http://www.agc.org>
- International Union of Operating Engineers, 1125 17th St. NW., Washington, DC 20036. Internet: <http://www.iuoe.org>

Construction Laborers

(O*NET 47-2061.00)

Significant Points

- Job opportunities should be good.
- The work can be physically demanding and sometimes dangerous.
- Most construction laborers learn through informal on-the-job training; some complete formal apprenticeship programs.

Nature of the Work

Construction laborers perform a wide range of physically demanding tasks involving building and highway construction, tunnel and shaft excavation, hazardous waste removal, and demolition. Although the term “laborer” implies work that requires relatively low skill or training, many tasks that these workers perform require a fairly high level of training and experience. Construction laborers clean and prepare construction sites to eliminate possible hazards, dig trenches, mix and place concrete, and set braces to support the sides of excavations. They load, unload, identify, and distribute building materials to the appropriate location according to project plans and specifications on building construction projects. They also tend machines; for example, they may mix concrete using a portable mixer or tend a machine that pumps concrete, grout, cement, sand, plaster, or stucco through a spray gun for application to ceilings and walls. Construction laborers may sometimes help other craft workers including carpenters, plasterers, and masons.

At heavy and highway construction sites, construction laborers clear and prepare highway work zones and rights of way; install traffic barricades, cones, and markers; and control traffic passing near, in, and around work zones. They also install sewer, water, and storm drain pipes, build manholes, and lay cement and asphalt on roads.

At hazardous waste removal sites, construction laborers prepare the site and safely remove asbestos, lead, radioactive waste, and other hazardous materials. They operate, read, and maintain air monitoring and other sampling devices in confined and/or hazardous environments. They also safely sample, identify, handle, pack, and transport hazardous and/or radioactive materials and clean and decontaminate equipment, buildings, and enclosed structures. Other highly specialized tasks include operating laser guidance equipment to place pipes, operating air and pneumatic drills, and transporting and setting explosives for tunnel, shaft, and road construction.

Construction laborers operate a variety of equipment including pavement breakers; jackhammers; earth tampers; concrete, mortar, and plaster mixers; electric and hydraulic boring machines; torches; small mechanical hoists; laser beam equipment; and surveying and measuring equipment. They operate pipe-laying machinery and use computers and other high-tech input devices to control robotic pipe cutters and cleaners. To perform their jobs effectively, construction laborers must be familiar with the duties of other craft workers and with the materials, tools, and machinery they use.

Construction laborers often work as part of a team with other skilled craft workers, jointly carrying out assigned construction tasks.



Construction laborers do much of the physically demanding labor at construction sites.

At other times, construction laborers may work alone, reading and interpreting instructions, plans, and specifications with little or no supervision.

While most construction laborers tend to specialize in a type of construction such as highway or tunnel construction, they are skilled generalists who perform many different tasks during all stages of construction. However, construction laborers who work in underground construction (such as in tunnels) or in demolition are more likely to specialize in only those areas.

Working Conditions

Most laborers do physically demanding work. They may lift and carry heavy objects, and stoop, kneel, crouch, or crawl in awkward positions. Some work at great heights, or outdoors in all weather conditions. Some jobs expose workers to harmful materials or chemicals, fumes, odors, loud noise, or dangerous machinery. To avoid injury, workers in these jobs wear safety clothing, such as gloves, hard hats, protective chemical suits, and devices to protect their eyes, respiratory system, or hearing. While working in underground construction, construction laborers must be especially alert to safely follow procedures and must deal with a variety of hazards.

Construction laborers generally work 8-hour shifts, although longer shifts also are common. They may work only during certain seasons, when the weather permits construction activity.

Employment

Construction laborers held about 791,000 jobs in 2000. They worked throughout the country but, like the general population, are concentrated in metropolitan areas. Almost all construction laborers work in the construction industry and almost 38 percent work for special trade contractors. Only about 8 percent worked part time in 2000.

Training, Other Qualifications, and Advancement

For some construction laborer jobs, employers hire people without experience or specific training in the occupation. However, the work requires more strength and stamina than most occupations, as well as a basic education. Basic literacy is a must if a worker is to read and comprehend warning signs and labels and understand instructions and specifications.

Most construction laborers learn their skills informally, observing and learning from experienced workers. Individuals who learn the trade on the job usually start as helpers. These workers perform routine tasks, such as cleaning and preparing the work-site and unloading materials. When the opportunity arises, they

learn how to do more difficult tasks, such as operating tools and equipment, from experienced craft workers. Becoming a fully skilled construction laborer by training on the job normally takes longer than the 2 to 4 years required to complete an apprenticeship program.

Formal apprenticeship programs provide more thorough preparation for jobs as construction laborers than does on-the-job training. Local apprenticeship programs are operated under guidelines established by the Laborers-Associated General Contractors of America Education and Training Fund. These programs typically require at least 4,000 hours of supervised on-the-job training and approximately 400 hours of classroom training. Depending on the availability of work and on local training schedules, it can take an individual from 2 to 4 years to complete the apprenticeship. A core curriculum consisting of basic construction skills such as blueprint reading, the correct use of tools and equipment, and knowledge of safety procedures comprises the first 200 hours. The remainder of the curriculum consists of specialized skills training in three of the largest segments of the construction industry: building construction, heavy/highway construction, and environmental remediation (cleaning up debris, landscaping, and restoring the environment to its original state). Workers who use dangerous equipment or handle toxic chemicals usually receive specialized training in safety awareness and procedures. Apprentices must complete at least 144 hours of classroom work each year.

Most apprenticeship programs require workers to be at least 18 years old (17 years of age or older in the case of some school-to-work and career preparation programs) and physically able to perform the work. Many apprenticeship programs require a high school diploma or equivalent. High school and junior college courses in science, physics, chemistry, and mathematics are helpful. Vocational classes in welding, construction, and other general building skills can give anyone wishing to become a construction laborer a significant head start.

Experience is helpful but usually is not necessary to obtain a job. Relevant work experience that provides construction-related job skills can often reduce or eliminate a wide range of training and apprenticeship requirements. Finally, most apprenticeship programs, local unions, and employers look very favorably on military service and/or service in the Job Corps, as veterans and Job Corps graduates have already demonstrated a high level of responsibility and reliability and may have gained many valuable job skills.

Construction laborers need good manual dexterity, hand-eye coordination, and balance. They also need the ability to read and comprehend all warning signs and labels on a construction site and the reading skills sufficient to understand and interpret plans, drawings, and written instructions and specifications. They should be capable of working as a member of a team and have basic problem-solving and math skills. Employers want workers who are hard-working, reliable, and diligent about being on time. Additionally, construction laborers who wish to work in environmental remediation must pass a physical test that measures the ability to wear a respirator. Computer skills also are important as construction becomes increasingly mechanized and computerized.

Experience in many construction laborer jobs may allow some workers to advance to positions such as supervisor or construction superintendent. A few become independent contractors.

Job Outlook

Job opportunities for construction laborers are expected to be good due to the numerous openings arising each year from laborers who

leave the occupation. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Employment of construction laborers is expected to grow about as fast as the average for all occupations through the year 2010. Opportunities will be best for well-trained workers who are willing to relocate to different worksites.

Growth of construction laborer employment will be spurred by continuing emphasis on environmental remediation and on rebuilding infrastructure—roads, airports, bridges, tunnels, and communications facilities, for example. However, employment growth will be adversely affected by automation as some jobs are replaced by new machines and equipment that improve productivity and quality.

Employment of construction laborers, like that of many other construction workers, can be variable or intermittent due to the limited duration of construction projects and the cyclical nature of the construction industry. During economic downturns, job openings for construction laborers decrease as the level of construction activity declines.

Earnings

Median hourly earnings of construction laborers in 2000 were \$11.15. The middle 50 percent earned between \$8.79 and \$16.23. The lowest 10 percent earned less than \$7.22 and the highest 10 percent earned more than \$21.88. Median hourly earnings in the largest industries employing construction laborers in 2000 were as follows:

Nonresidential building construction	\$11.85
Miscellaneous special trade contractors	11.71
Concrete work	11.27
Heavy construction, except highway	10.90
Residential building construction	10.62

Earnings for construction laborers can be reduced by poor weather or by downturns in construction activity, which sometimes result in layoffs.

Apprentices or helpers usually start at about 50 percent of the wage rate paid to experienced workers. Pay increases as apprentices gain experience and learn new skills.

Almost 1 in 5 construction laborers are members of a union. Many belong to the Laborers' International Union of North America.

Related Occupations

The work of construction laborers is closely related to other construction occupations. Other workers who perform similar physical work include persons in material moving occupations; forest, conservation, and logging workers; and grounds maintenance workers.

Sources of Additional Information

For information about jobs as construction laborers, contact local building or construction contractors, local joint labor-management apprenticeship committees, apprenticeship agencies, or the local office of your State Employment Service.

For general information about the work of construction laborers, contact:

► Laborers' International Union of North America, 905 16th St. NW., Washington, DC 20006. Internet: <http://www.liuna.org>

Drywall Installers, Ceiling Tile Installers, and Tapers

(O*NET 47-2081.01, 47-2081.02, 47-2082.00)

Significant Points

- Most workers learn the trade on the job, either by working as helpers or through a formal apprenticeship.
- Job prospects are expected to be excellent.
- Inclement weather seldom interrupts work, but workers may be idled when downturns in the economy slow new construction activity.

Nature of the Work

Drywall consists of a thin layer of gypsum between two layers of heavy paper. It is used for walls and ceilings in most buildings today because it is both faster and cheaper to install than plaster.

There are two kinds of drywall workers—installers and tapers—although many workers do both types of work. Installers, also called *applicators*, fasten drywall panels to the inside framework of residential houses and other buildings. *Tapers*, or *finishers*, prepare these panels for painting by taping and finishing joints and imperfections.

Because drywall panels are manufactured in standard sizes—usually 4 feet by 8 or 12 feet—drywall installers must measure, cut, and fit some pieces around doors and windows. They also saw or cut holes in panels for electrical outlets, air-conditioning units, and plumbing. After making these alterations, installers may glue, nail, or screw the wallboard panels to the wood or metal framework. Because drywall is heavy and cumbersome, a helper generally assists the installer in positioning and securing the panel. A lift often is used when placing ceiling panels.

After the drywall is installed, tapers fill joints between panels with a joint compound. Using the wide, flat tip of a special trowel, they spread the compound into and along each side of the joint with brush-like strokes. They immediately use the trowel to press a paper tape—used to reinforce the drywall and to hide imperfections—into the wet compound and to smooth away excess material. Nail and screw depressions also are covered with this compound, as are imperfections caused by the installation of air-conditioning vents and other fixtures. On large commercial projects, finishers may use automatic taping tools that apply the joint compound and tape in one step. Tapers apply second and third coats of the compound, sanding the treated areas after each coat to make them as smooth as the rest of the wall surface. This results in a very smooth and almost perfect surface. Some tapers apply textured surfaces to walls and ceilings with trowels, brushes, or spray guns.

Ceiling tile installers, or *acoustical carpenters*, apply or mount acoustical tiles or blocks, strips, or sheets of shock-absorbing materials to ceilings and walls of buildings to reduce reflection of sound or to decorate rooms. First, they measure and mark the surface according to blueprints and drawings. Then, they nail or screw moldings to the wall to support and seal the joint between the ceiling tile and the wall. Finally, they mount the tile, either by applying a cement adhesive to the back of the tile and then pressing the tile into place or by nailing, screwing, stapling, or wire-tying the lath directly to the structural framework.

Also included in this occupation are *lathers*. Lathers fasten metal or rockboard lath to walls, ceilings, and partitions of buildings. Lath forms the support base for plaster, fireproofing, or acoustical materials. At one time, lath was made of wooden strips. Now, lathers work



Drywall installers patch drywall prior to sanding and painting.

mostly with wire, metal mesh, or rockboard lath. Metal lath is used where the plaster application will be exposed to weather or water or for curved or irregular surfaces for which drywall is not a practical material. Using hand tools and portable power tools, lathers nail, screw, staple, or wire-tie the lath directly to the structural framework.

Working Conditions

As in many other construction trades, this work sometimes is strenuous. Drywall installers, ceiling tile installers, and tapers spend most of the day on their feet, either standing, bending, or kneeling. Some tapers use stilts to tape and finish ceiling and angle joints. Installers have to lift and maneuver heavy panels. Hazards include falls from ladders and scaffolds and injuries from power tools and from working with sharp materials. Because sanding a joint compound to a smooth finish creates a great deal of dust, some finishers wear masks for protection.

Employment

Drywall installers, ceiling tile installers, and tapers held about 188,000 jobs in 2000. Most worked for contractors specializing in drywall and ceiling tile installation; others worked for contractors doing many kinds of construction. About 38,000 were self-employed independent contractors.

Most installers and tapers are employed in populous areas. In other areas, where there may not be enough work to keep a drywall or a ceiling tile installer employed full time, carpenters and painters usually do the work.

Training, Other Qualifications, and Advancement

Most drywall installers, ceiling tile installers, and tapers start as helpers and learn their skills on the job. Installer helpers start by carrying materials, lifting and holding panels, and cleaning up debris. Within a few weeks, they learn to measure, cut, and install materials. Eventually, they become fully experienced workers. Taper apprentices begin by taping joints and touching up nail holes, scrapes, and other imperfections. They soon learn to install corner guards and to conceal openings around pipes. At the end of their training, drywall installers, ceiling tile installers, and tapers learn to estimate the cost of installing and finishing drywall.

Some drywall installers, ceiling tile installers, and tapers learn their trade in an apprenticeship program. The United Brotherhood of Carpenters and Joiners of America, in cooperation with local contractors, administers an apprenticeship program in both drywall installation and finishing and acoustical carpentry. Apprenticeship programs consist of at least 3 years, or 6,000 hours, of on-the-job training and 144 hours a year of related classroom instruction. In addition, local affiliates of the Associated Builders and Contractors and the National Association of Home Builders conduct training programs for nonunion workers. The International Brotherhood of Painters and Allied Trades conducts an apprenticeship program in drywall finishing that lasts 2 to 3 years.

Employers prefer high school graduates who are in good physical condition, but they frequently hire applicants with less education. High school or vocational school courses in carpentry provide a helpful background for drywall work. Regardless of educational background, installers must be good at simple arithmetic. Other useful high school courses include English, wood shop, metal shop, blueprint reading, and mechanical drawing.

Drywall installers, ceiling tile installers, and tapers with a few years' experience and with leadership ability may become supervisors. Some workers start their own contracting businesses.

Job Outlook

Job opportunities for drywall installers, ceiling tile installers, and tapers are expected to be excellent through 2010, partly due to a shortage of adequate training programs. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment is expected to grow more slowly than the average for all occupations over the 2000-10 period, reflecting increases in new construction and remodeling. In addition to traditional interior work, the growing acceptance of insulated exterior wall systems will provide additional jobs for drywall workers.

In addition to those resulting from job growth, many jobs will open up each year because of the need to replace workers who transfer to other occupations or leave the labor force. Because of their relatively weak attachment to the occupation, many drywall installers, ceiling tile installers, and tapers with limited skills leave the occupation when they find that they dislike the work or fail to find steady employment.

Despite the growing use of exterior panels, most drywall installation and finishing is done indoors. Therefore, drywall workers lose less worktime because of inclement weather than do some other construction workers. Nevertheless, they may be unemployed between construction projects and during downturns in construction activity.

Earnings

In 2000, the median hourly earnings of drywall and ceiling tile installers were \$15.80. The middle 50 percent earned between \$12.27 and \$20.81. The lowest 10 percent earned less than \$9.68, and the

highest 10 percent earned more than \$26.86. The median hourly earnings in the largest industries employing drywall and ceiling tile installers in 2000 were:

Nonresidential building construction	\$16.18
Residential building construction	15.96
Masonry, stonework, and plastering	15.93

In 2000, the median hourly earnings of tapers were \$17.81. The middle 50 percent earned between \$13.99 and \$23.34. The lowest 10 percent earned less than \$11.06, and the highest 10 percent earned more than \$27.62. The median hourly earnings of tapers in 2000 in masonry, stonework, and plastering were \$17.67.

Trainees usually started at about half the rate paid to experienced workers, and received wage increases as they became more highly skilled.

Some contractors pay these workers according to the number of panels they install or finish per day; others pay an hourly rate. A 40-hour week is standard, but the workweek may sometimes be longer. Workers who are paid hourly rates receive premium pay for overtime.

Related Occupations

Drywall installers, ceiling tile installers, and tapers combine strength and dexterity with precision and accuracy to make materials fit according to a plan. Other occupations that require similar abilities include carpenters; carpet, floor, and tile installers and finishers; insulation workers; and plasterers and stucco masons.

Sources of Additional Information

For information about work opportunities in drywall application and finishing and ceiling tile installation, contact local drywall installation and ceiling tile installation contractors, a local of the unions previously mentioned, a local joint union-management apprenticeship committee, a State or local chapter of the Associated Builders and Contractors, or the nearest office of the State employment service or apprenticeship agency.

For details about job qualifications and training programs in drywall application and finishing and ceiling tile installation, write to:

- Associated Builders and Contractors, Inc., 1300 N. 17th St., Arlington, VA 22209. Internet: <http://www.abc.org>
- National Association of Home Builders, 1201 15th St. NW., Washington, DC 20005. Internet: <http://www.nahb.com>
- International Brotherhood of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006. Internet: <http://www.ibpat.org>
- United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, DC 20001.

Electricians

(O*NET 47-2111.00)

Significant Points

- Job opportunities are expected to be excellent for qualified electricians.
- Most electricians acquire their skills by completing a formal 4- or 5-year apprenticeship program.
- About one-third of all electricians work in industries other than construction.

Nature of the Work

Electricity is essential for light, power, air conditioning, and refrigeration. Electricians install, connect, test, and maintain electrical

systems for a variety of purposes, including climate control, security, and communications. They also may install and maintain the electronic controls for machines in business and industry. Although most electricians specialize in either construction or maintenance, a growing number do both.

Electricians work with blueprints when they install electrical systems in factories, office buildings, homes, and other structures. Blueprints indicate the locations of circuits, outlets, load centers, panel boards, and other equipment. Electricians must follow the National Electric Code and comply with State and local building codes when they install these systems. In factories and offices, they first place conduit (pipe or tubing) inside designated partitions, walls, or other concealed areas. They also fasten to the wall small metal or plastic boxes that will house electrical switches and outlets. They then pull insulated wires or cables through the conduit to complete circuits between these boxes. In lighter construction, such as residential, plastic-covered wire usually is used instead of conduit.

Regardless of the type of wire used, electricians connect it to circuit breakers, transformers, or other components. They join the wires in boxes with various specially designed connectors. After they finish the wiring, they use testing equipment, such as ohmmeters, voltmeters, and oscilloscopes, to check the circuits for proper connections, ensuring electrical compatibility and safety of components.

In addition to wiring a building's electrical system, electricians may install coaxial or fiber optic cable for computers and other telecommunications equipment. A growing number of electricians install telephone systems, computer wiring and equipment, street lights, intercom systems, and fire alarm and security systems. They also may connect motors to electrical power and install electronic controls for industrial equipment.

Maintenance work varies greatly, depending on where the electrician is employed. Electricians who specialize in residential work may rewire a home and replace an old fuse box with a new circuit breaker to accommodate additional appliances. Those who work in large factories may repair motors, transformers, generators, and electronic controllers on machine tools and industrial robots. Those in office buildings and small plants may repair all types of electrical equipment.

Maintenance electricians spend much of their time in preventive maintenance. They periodically inspect equipment, and locate and correct problems before breakdowns occur. Electricians may also advise management on whether continued operation of equipment could be hazardous. When needed, they install new electrical equipment. When breakdowns occur, they must make

the necessary repairs as quickly as possible in order to minimize inconvenience. Electricians may replace items such as circuit breakers, fuses, switches, electrical and electronic components, or wire. When working with complex electronic devices, they may work with engineers, engineering technicians, or industrial machinery installation, repair, and maintenance workers. (For information about each of these occupations, see the statements located elsewhere in the *Handbook*.)

Electricians use handtools such as screwdrivers, pliers, knives, and hacksaws. They also use power tools and testing equipment such as oscilloscopes, ammeters, and test lamps.

Working Conditions

Electricians' work is sometimes strenuous. They may stand for long periods and frequently work on ladders and scaffolds. Their working environment varies, depending on the type of job. Some may work in dusty, dirty, hot, or wet conditions, or in confined areas, ditches, or other uncomfortable places. Electricians risk injury from electrical shock, falls, and cuts; to avoid injuries, they must follow strict safety procedures. Some electricians may have to travel to jobsites, which may be up to 100 miles away.

Most electricians work a standard 40-hour week, although overtime may be required. Those in maintenance work may work nights or weekends, and be on call. Companies that operate 24 hours a day may employ three shifts of electricians.

Employment

Electricians held about 698,000 jobs in 2000. About two-thirds were employed in the construction industry. About one-third worked as maintenance electricians and were employed outside the construction industry. In addition, about 8 percent of electricians were self-employed.

Because of the widespread need for electrical services, jobs for electricians are found in all parts of the country.

Training, Other Qualifications, and Advancement

Most people learn the electrical trade by completing a 4- or 5-year apprenticeship program. Apprenticeship gives trainees a thorough knowledge of all aspects of the trade and generally improves their ability to find a job. Although more electricians are trained through apprenticeship than are workers in other construction trades, some still learn their skills informally, on the job.

Apprenticeship programs may be sponsored by joint training committees made up of local unions of the International Brotherhood of Electrical Workers and local chapters of the National Electrical Contractors Association; company management committees of individual electrical contracting companies; or by local chapters of the Associated Builders and Contractors and the Independent Electrical Contractors Association. Training also may be provided by company management committees of individual electrical contracting companies and by local chapters of the Associated Builders and Contractors and the Independent Electrical Contractors. Because of the comprehensive training received, those who complete apprenticeship programs qualify to do both maintenance and construction work.

The typical large apprenticeship program provides at least 144 hours of classroom instruction each year, and 8,000 hours of on-the-job training over the course of the apprenticeship. In the classroom, apprentices learn blueprint reading, electrical theory, electronics, mathematics, electrical code requirements, and safety and first aid practices. They also may receive specialized training in welding, communications, fire alarm systems, and cranes and elevators. On the job, under the supervision of experienced electricians, apprentices must demonstrate mastery of the electrician's



Electricians lay out conduit for electric wires.

work. At first, they drill holes, set anchors, and set up conduit. Later, they measure, fabricate, and install conduit, as well as install, connect, and test wiring, outlets, and switches. They also learn to set up and draw diagrams for entire electrical systems.

Those who do not enter a formal apprenticeship program can begin to learn the trade informally by working as helpers for experienced electricians. While learning to install conduit, connect wires, and test circuits, helpers also learn safety practices. Many helpers supplement this training with trade school or correspondence courses.

Regardless of how one learns the trade, previous training is very helpful. High school courses in mathematics, electricity, electronics, mechanical drawing, science, and shop provide a good background. Special training offered in the Armed Forces and by postsecondary technical schools also is beneficial. All applicants should be in good health and have at least average physical strength. Agility and dexterity also are important. Good color vision is needed because workers must frequently identify electrical wires by color.

Most apprenticeship sponsors require applicants for apprentice positions to be at least 18 years old and have a high school diploma or its equivalent. For those interested in becoming maintenance electricians, a background in electronics is increasingly important because of the growing use of complex electronic controls on manufacturing equipment.

Most localities require electricians to be licensed. Although licensing requirements vary from area to area, electricians usually must pass an examination that tests their knowledge of electrical theory, the National Electrical Code, and local electric and building codes.

Electricians periodically take courses offered by their employer or union to keep abreast of changes in the National Electrical Code, materials, or methods of installation.

Experienced electricians can become supervisors and then superintendents. Those with sufficient capital and management skills may start their own contracting business, although this may require an electrical contractor's license.

Job Outlook

Job opportunities for skilled electricians are expected to be excellent, largely due to the numerous openings arising each year from experienced electricians who leave the occupation. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment of electricians is expected to increase about as fast as the average for all occupations through the year 2010. As the population and economy grow, more electricians will be needed to install and maintain electrical devices and wiring in homes, factories, offices, and other structures. New technologies also are expected to continue to stimulate the demand for these workers. Increasingly, buildings will be prewired during construction to accommodate use of computers and telecommunications equipment. More factories will be using robots and automated manufacturing systems. Installation of this equipment, which is expected to increase, should also stimulate demand for electricians. Additional jobs will be created by rehabilitation and retrofitting of existing structures.

In addition to jobs created by increased demand for electrical work, many openings will occur each year as electricians transfer to other occupations, retire, or leave the labor force for other reasons. Because of their lengthy training and relatively high earnings, a smaller proportion of electricians than of other craftworkers leave their occupation each year. The number of retirements is expected to rise, however, as more electricians reach retirement age.

Employment of construction electricians, like that of many other construction workers, is sensitive to changes in the economy. This

results from the limited duration of construction projects and the cyclical nature of the construction industry. During economic downturns, job openings for electricians are reduced as the level of construction activity declines. Apprenticeship opportunities also are less plentiful during these periods.

Although employment of maintenance electricians is steadier than that of construction electricians, those working in the automotive and other manufacturing industries that are sensitive to cyclical swings in the economy may be laid off during recessions. Also, efforts to reduce operating costs and increase productivity, through the increased use of contracting out for electrical services, may limit opportunities for maintenance electricians in many industries. However, this should be partially offset by increased demand by electrical contracting firms.

Job opportunities for electricians also vary by area. Employment opportunities follow the movement of people and businesses among States and local areas, and reflect differences in local economic conditions. The number of job opportunities in a given year may fluctuate widely from area to area.

Earnings

In 2000, median hourly earnings of electricians were \$19.29. The middle 50 percent earned between \$14.49 and \$25.41. The lowest 10 percent earned less than \$11.31, and the highest 10 percent earned more than \$31.71. Median hourly earnings in the industries employing the largest numbers of electricians in 2000 are shown below:

Motor vehicles and equipment	\$26.71
Local government	19.88
Electrical work	19.22
Heavy construction, except highway	17.92
Plumbing, heating, and air-conditioning	17.26

Depending on experience, apprentices usually start at between 30 and 50 percent of the rate paid to experienced electricians. As they become more skilled, they receive periodic increases throughout the course of the apprenticeship program. Many employers also provide training opportunities for experienced electricians to improve their skills.

Many construction electricians are members of the International Brotherhood of Electrical Workers. Among unions organizing maintenance electricians are the International Brotherhood of Electrical Workers; the International Union of Electronic, Electrical, Salaried, Machine, and Furniture Workers; the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aircraft and Agricultural Implement Workers of America; and the United Steelworkers of America.

Related Occupations

To install and maintain electrical systems, electricians combine manual skill and knowledge of electrical materials and concepts. Workers in other occupations involving similar skills include heating, air-conditioning, and refrigeration mechanics and installers; line installers and repairers; electrical and electronics installers and repairers; electronic home entertainment equipment installers and repairers; and elevator installers and repairers.

Sources of Additional Information

For details about apprenticeships or other work opportunities in this trade, contact the offices of the State employment service, the State apprenticeship agency, local electrical contractors or firms that employ maintenance electricians, or local union-management electrician apprenticeship committees. This information may also be available from local chapters of the Independent Electrical

Contractors, Inc.; the National Electrical Contractors Association; the Home Builders Institute; the Associated Builders and Contractors; and the International Brotherhood of Electrical Workers.

For general information about the work of electricians, contact:

- Independent Electrical Contractors, Inc., 2010-A Eisenhower Ave., Alexandria, VA 22314. Internet: <http://www.ieci.org>
- National Electrical Contractors Association (NECA), 3 Metro Center, Suite 1100, Bethesda, MD 20814. Internet: <http://www.necanet.org>
- International Brotherhood of Electrical Workers (IBEW), 1125 15th St. NW., Washington, DC 20005. Internet: <http://www.ibew.org>
- Associated Builders and Contractors, 1300 N. 17th St., Arlington, VA 22209. Internet: <http://www.abc.org>
- National Association of Home Builders, 1201 15th St. NW., Washington, DC 20005. Internet: <http://www.nahb.org>

Elevator Installers and Repairers

(O*NET 47-4021.00)

Significant Points

- Workers learn the trade through 4 to 5 years of on-the-job training and classroom instruction.
- Elevator installers and repairers have one of the highest rates of union membership.
- Job opportunities are expected to be limited in this small occupation; prospects should be best for those with postsecondary education in electronics.

Nature of the Work

Elevator installers and repairers—also called *elevator constructors* or *elevator mechanics*—assemble, install, and replace elevators, escalators, dumbwaiters, moving walkways, and similar equipment in new and old buildings. Once the equipment is in service, they maintain and repair it as well. They also are responsible for modernizing older equipment.

To install, repair, and maintain modern elevators, which are almost all electronically controlled, elevator installers and repairers must have a thorough knowledge of electronics, electricity, and hydraulics. Many elevators are controlled with microprocessors, which are programmed to analyze traffic conditions in order to dispatch elevators in the most efficient manner. With these computer controls, it is possible to get the greatest amount of service with the least number of cars.

When installing a new elevator, installers and repairers begin by studying blueprints to determine the equipment needed to install rails, machinery, car enclosures, motors, pumps, cylinders, and plunger foundations. Once this has been done, they begin equipment installation. Working on scaffolding or platforms, installers bolt or weld steel rails to the walls of the shaft to guide the elevator.

Elevator installers put in electrical wires and controls by running tubing, called conduit, along a shaft's walls from floor to floor. Once it is in place, mechanics pull plastic-covered electrical wires through the conduit. They then install electrical components and related devices required at each floor and at the main control panel in the machine room.

Installers bolt or weld together the steel frame of an elevator car at the bottom of the shaft; install the car's platform, walls, and doors; and attach guide shoes and rollers to minimize the lateral motion of the car as it travels through the shaft. They also install the outer doors and door frames at the elevator entrances on each floor.

For cabled elevators, these workers install geared or gearless machines with a traction drive wheel that guides and moves heavy



Elevator installers need a working knowledge of electricity, electronics, and hydraulics.

steel cables connected to the elevator car and counterweight. (The counterweight moves in the opposite direction from the car and balances most of the weight of the car to reduce the weight that the elevator's motor must lift.) Elevator installers also install elevators in which a car sits on a hydraulic plunger that is driven by a pump. The plunger pushes the elevator car up from underneath, similar to a lift in an auto service station.

Installers and repairers also install escalators. They put in place the steel framework, the electrically powered stairs, and the tracks and install associated motors and electrical wiring. In addition to elevators and escalators, they also may install devices such as dumbwaiters and material lifts—which are similar to elevators in design—as well as moving walkways, stair lifts, and wheelchair lifts.

The most highly skilled elevator installers and repairers, called “adjusters,” specialize in fine-tuning all the equipment after installation. Adjusters make sure that an elevator is working according to specifications, such as stopping correctly at each floor within a specified time. Once an elevator is operating properly, it must be maintained and serviced regularly to keep it in safe working condition. Elevator installers and repairers generally do preventive maintenance—such as oiling and greasing moving parts, replacing worn parts, testing equipment with meters and gauges, and adjusting equipment for optimal performance. They also troubleshoot and may be called in to do emergency repairs.

A service crew usually handles major repairs—for example, replacing cables, elevator doors, or machine bearings. This may require the use of cutting torches or rigging equipment—tools an elevator repairer normally would not carry. Service crews also do major modernization and alteration work, such as moving and replacing electrical motors, hydraulic pumps, and control panels.

Elevator installers and repairers usually specialize in installation, maintenance, or repair work. Maintenance and repair workers generally need more knowledge of electricity and electronics than installers do, because a large part of maintenance and repair work is troubleshooting. Similarly, adjusters need a thorough knowledge of electricity, electronics, and computers to ensure that newly installed elevators operate properly.

Working Conditions

Most elevator installers and repairers work a 40-hour week. However, overtime is required when essential elevator equipment must be repaired, and some workers are on 24-hour call. Unlike most elevator installers, workers who specialize in elevator maintenance

are on their own most of the day and typically service the same elevators periodically.

Elevator installers lift and carry heavy equipment and parts, and may work in cramped spaces or awkward positions. Potential hazards include falls, electrical shock, muscle strains, and other injuries related to handling heavy equipment. Because most of their work is performed indoors in buildings under construction or in existing buildings, elevator installers and repairers lose less worktime due to inclement weather than do other construction trades workers.

Employment

Elevator installers and repairers held about 23,000 jobs in 2000. Most were employed by special trade contractors. Others were employed by field offices of elevator manufacturers, wholesale distributors, small-elevator maintenance and repair contractors, government agencies, or businesses that do their own elevator maintenance and repair.

Training, Other Qualifications, and Advancement

Most elevator installers and repairers apply for their jobs through a local of the International Union of Elevator Constructors. Applicants for trainee positions must be at least 18 years old, have a high school diploma or equivalent, and pass an aptitude test. Good physical condition and mechanical aptitude also are important.

Elevator installers and repairers learn their trade in a program administered by local joint educational committees representing the employers and the union. These programs, through which the trainee learns everything from installation to repair, combine on-the-job training with classroom instruction in blueprint reading, electrical and electronic theory, mathematics, applications of physics, and safety. In nonunion shops, workers may complete training programs sponsored by independent contractors.

Generally, trainees or helpers must complete a 6-month probationary period. After successful completion, they work toward becoming fully qualified within 4 to 5 years. To be classified as a fully qualified elevator installer or repairer, union trainees must pass a standard examination administered by the National Elevator Industry Educational Program. Most States and cities also require elevator installers and repairers to pass a licensing examination.

Most trainees or helpers assist experienced elevator installers and repairers. Beginners carry materials and tools, bolt rails to walls, and assemble elevator cars. Eventually, trainees learn more difficult tasks such as wiring, which requires knowledge of local and national electrical codes.

High school courses in electricity, mathematics, and physics provide a useful background. As elevators become increasingly sophisticated, workers may find it necessary to acquire more advanced formal education—for example, in postsecondary technical school or junior college—with an emphasis on electronics. Workers with more formal education usually advance more quickly than their counterparts.

Many elevator installers and repairers also receive training from their employers or through manufacturers to become familiar with a company's particular equipment. Retraining is very important to keep abreast of technological developments in elevator repair. In fact, union elevator installers and repairers typically receive continual training throughout their careers, through either correspondence courses, seminars, or formal classes. Although voluntary, this training greatly improves one's chances for promotion.

Some installers may receive further training in specialized areas and advance to mechanic-in-charge, adjuster, supervisor, or elevator inspector. Adjusters, for example, may be picked for their position because they possess particular skills or are electronically inclined. Other workers may move into management, sales, or product design jobs.

Job Outlook

Job opportunities are expected to be somewhat limited in this small occupation. A large proportion of elevator installer and repairer jobs are unionized and involve a significant investment in training. As a result, workers tend to stay in this occupation for a long time. This investment in training, as well as good benefits and relatively high wages, results in fewer openings due to turnover, thus reducing job opportunities. Job prospects should be best for those with postsecondary education in electronics.

Employment of elevator installers and repairers is expected to increase about as fast as the average for all occupations through the year 2010. Job growth is related to the growth of nonresidential construction, such as commercial office buildings and stores that have elevators and escalators, which is expected to increase about as fast as the average over the 2000-10 period. The need to continually update and modernize old equipment, including improvements in appearance and the installation of increasingly sophisticated equipment and computerized controls, also should add to the demand for elevator installers and repairers.

Because it is desirable that equipment always be kept in good working condition, economic downturns will have less of an effect on employment of elevator installers and repairers than on other construction trades.

Earnings

Median hourly earnings of elevator installers and repairers were \$22.78 in 2000. The middle 50 percent earned between \$16.38 and \$27.38. The lowest 10 percent earned less than \$11.19, and the top 10 percent earned more than \$33.23. In 2000, median hourly earnings in the miscellaneous special trade contractors industry were \$23.29.

In addition to free continuing education, elevator installers and repairers receive basic benefits enjoyed by most other workers.

Elevator installers and repairers have one of the highest rates of union membership, about 9 out of 10. Most elevator installers and repairers belong to the International Union of Elevator Constructors.

Related Occupations

Elevator installers and repairers combine electrical and mechanical skills with construction skills, such as welding, rigging, measuring, and blueprint reading. Other occupations that require many of these skills are boilermakers; electricians; electrical and electronics installers and repairers; industrial machinery installation, repair, and maintenance workers; sheet metal workers; and structural and reinforcing iron and metal workers.

Sources of Additional Information

For further details about opportunities as an elevator installer and repairer, contact elevator manufacturers, elevator repair and maintenance contractors, a local of the International Union of Elevator Constructors, or the nearest local public employment service office.

Glaziers

(O*NET 47-2121.00)

Significant Points

- Glaziers may be injured by broken glass or cutting tools, falls from scaffolds, or from improperly lifting heavy glass panels.
- Many glaziers learn the trade by working as helpers to experienced glaziers; however, employers recommend a 3- to 4-year apprenticeship program.
- Job opportunities are expected to be excellent.

Nature of the Work

Glass serves many uses in modern buildings. Insulated and specially treated glass keeps in warmed or cooled air and provides good condensation and sound control qualities; tempered and laminated glass makes doors and windows more secure. In large commercial buildings, glass panels give office buildings a distinctive look while reducing the need for artificial lighting. The creative use of large windows, glass doors, skylights, and sun-room additions makes homes bright, airy, and inviting.

Glaziers are responsible for selecting, cutting, installing, replacing, and removing all types of glass. They generally work on one of several types of projects. Residential glazing involves work such as replacing glass in home windows; installing glass mirrors, shower doors, and bathtub enclosures; and fitting glass for table tops and display cases. On commercial interior projects, glaziers install items such as heavy, often etched, decorative room dividers or security windows. Glazing projects also may involve replacement of storefront windows for establishments such as supermarkets, auto dealerships, or banks. In the construction of large commercial buildings, glaziers build metal framework extrusions and install glass panels or curtain walls.

Besides working with glass, glaziers also may work with plastics, granite, marble, and similar materials used as glass substitutes. They may mount steel and aluminum sashes or frames and attach locks and hinges to glass doors. For most jobs, the glass is precut and mounted in frames at a factory or a contractor's shop. It arrives at the jobsite ready for glaziers to position and secure it in place. They may use a crane or hoist with suction cups to lift large, heavy pieces of glass. They then gently guide the glass into position by hand.

Once glaziers have the glass in place, they secure it with mastic, putty, or other pastelike cement, or with bolts, rubber gaskets, glazing compound, metal clips, or metal or wood moldings. When they secure glass using a rubber gasket—a thick, molded rubber half-tube with a split running its length—they first secure the gasket around the perimeter within the opening, then set the glass into the split side of the gasket, causing it to clamp to the edges and hold the glass firmly in place.

When they use metal clips and wood moldings, glaziers first secure the molding to the opening, place the glass in the molding, and then force springlike metal clips between the glass and the molding. The clips exert pressure and keep the glass firmly in place.

When a glazing compound is used, glaziers first spread it neatly against and around the edges of the molding on the inside of the opening. Next, they install the glass. Pressing it against the compound on the inside molding, workers screw or nail outside molding that loosely holds the glass in place. To hold it firmly, they pack the space between the molding and the glass with glazing compound and then trim any excess material with a glazing knife.

For some jobs, the glazier must cut the glass manually at the jobsite. To prepare the glass for cutting, glaziers rest it either on edge on a rack, or "A-frame," or flat against a cutting table. They then measure and mark the glass for the cut.

Glaziers cut glass with a special tool that has a small, very hard metal wheel. Using a straightedge as a guide, the glazier presses the cutter's wheel firmly on the glass, guiding and rolling it carefully to make a score just below the surface. To help the cutting tool move smoothly across the glass, workers brush a thin layer of oil along the line of the intended cut or dip the cutting tool in oil. Immediately after cutting, the glazier presses on the shorter end of the glass to break it cleanly along the cut.

Glaziers also replace or repair broken or pitted windshields and window glass on automobiles and other vehicles. They first remove the broken glass, which may involve cutting it free from the adhesive holding it down. They then install the glass in the vehicle,



Many glaziers learn the trade by working as helpers to experienced workers.

often using a special adhesive. They also may weatherproof the window or windshield and prevent it from rattling by installing rubber strips around the sides of the glass.

In addition to handtools such as glass cutters, suction cups, and glazing knives, glaziers use power tools such as saws, drills, cutters, and grinders. An increasing number of glaziers use computers in the shop or at the jobsite to improve their layout work and reduce the amount of glass that is wasted.

Working Conditions

Glaziers often work outdoors, sometimes in inclement weather. At times, they work on scaffolds at great heights. They do a considerable amount of bending, kneeling, lifting, and standing. Glaziers may be injured by broken glass or cutting tools, by falls from scaffolds, or by improperly lifting heavy glass panels.

Employment

Glaziers held about 49,000 jobs in 2000. About 3 out of every 5 glaziers worked for glazing contractors engaged in new construction, alteration, and repair. About 1 out of 5 worked in retail glass shops that install or replace glass and for wholesale distributors of products containing glass. Others worked in automotive repair shops.

Training, Other Qualifications, and Advancement

Many glaziers learn the trade informally on the job. They usually start as helpers, carrying glass and cleaning up debris in glass shops. They often practice cutting on discarded glass. After a while, they are given an opportunity to cut glass for a job. Eventually, helpers assist experienced workers on simple installation jobs. By working with experienced glaziers, they eventually acquire the skills of a fully qualified glazier.

Employers recommend that glaziers learn the trade through a formal apprenticeship program that lasts 3 to 4 years. Apprenticeship programs, which are administered by the National Glass Association and local union-management committees or local contractors' associations, consist of on-the-job training, as well as 144 hours of classroom instruction or home study each year. On the job, apprentices learn to use the tools and equipment of the trade; handle, measure, cut, and install glass and metal framing; cut and fit moldings; and install and balance glass doors. In the classroom, they are taught basic mathematics, blueprint reading and sketching, general construction techniques, safety practices, and first aid. Learning the

trade through an apprenticeship program usually takes less time and provides more complete training than acquiring skills informally on the job, but opportunities for apprenticeships are declining.

Local apprenticeship administrators determine the physical, age, and educational requirements needed by applicants for apprenticeships and for helper positions. In general, applicants must be in good physical condition and be at least 17 years old. High school or vocational school graduates are preferred. In some areas, applicants must take mechanical-aptitude tests. Courses in general mathematics, blueprint reading or mechanical drawing, general construction, and shop provide a good background.

Standards for acceptance into apprenticeship programs are rising to reflect changing requirements associated with new products and equipment. In addition, the growing use of computers in glass layout requires that glaziers be familiar with personal computers.

Because many glaziers do not learn the trade through a formal apprenticeship program, the National Glass Association (NGA) offers a series of written examinations that certify an individual's competency to perform glazier work at three progressively more difficult levels of proficiency. These levels include Level I, Glazier; Level II, Commercial Interior/Residential Glazier or Storefront/Curtainwall Glazier; and Level III, Master Glazier. Recently, the NGA has added a new certification program for auto-glass repair.

Advancement generally consists of increases in pay for most glaziers; some advance to supervisory jobs or become contractors or estimators.

Job Outlook

Job opportunities are expected to be excellent for glaziers, largely due to the numerous openings arising each year as experienced glaziers leave the occupation. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment of glaziers is expected to increase about as fast as the average for all occupations through the year 2010, as a result of growth in residential and nonresidential construction. Demand for glaziers will be spurred by the continuing need to modernize and repair existing structures and the popularity of glass in bathroom and kitchen design. Improved glass performance in the areas of insulation, privacy, safety, condensation control, and noise reduction also are expected to contribute to the demand for glaziers in both residential and nonresidential remodeling. A continuing emphasis on energy management, which encourages people to replace their old windows and doors with high-efficiency products, also will spur the demand for glaziers.

Similar to other construction-trades workers, construction glaziers should expect to experience periods of unemployment resulting from the limited duration of construction projects and the cyclical nature of the construction industry. During bad economic times, job openings for glaziers are reduced as the level of construction declines. Because construction activity varies from area to area, job openings, as well as apprenticeship opportunities, fluctuate with local economic conditions. Employment and apprenticeship opportunities should be greatest in metropolitan areas, where most glazing contractors and glass shops are located.

Earnings

In 2000, median hourly earnings of glaziers were \$14.32. The middle 50 percent earned between \$10.88 and \$19.35. The lowest 10 percent earned less than \$8.50, and the highest 10 percent earned more than \$25.78. Median hourly earnings in the industries employing the largest numbers of glaziers in 2000 are shown below:

Miscellaneous special trade contractors	\$15.39
Paint, glass, and wallpaper stores	12.60

Glaziers covered by union contracts generally earn more than their nonunion counterparts. Apprentice wage rates usually start at 50 to 60 percent of the rate paid to experienced glaziers and increase every 6 months. Because glaziers can lose time due to weather conditions and fluctuations in construction activity, their overall earnings may be lower than their hourly wages suggest.

Many glaziers employed in construction are members of the International Brotherhood of Painters and Allied Trades.

Related Occupations

Glaziers use their knowledge of construction materials and techniques to install glass. Other construction workers whose jobs also involve skilled, custom work are brickmasons, blockmasons, and stonemasons; carpenters; carpet, floor, and tile installers and finishers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; and painters and paperhangers.

Sources of Additional Information

For more information about glazier apprenticeships or work opportunities, contact local glazing or general contractors, a local of the International Brotherhood of Painters and Allied Trades, a local joint union-management apprenticeship agency, or the nearest office of the State employment service or State apprenticeship agency.

For general information about the work of glaziers, contact:

➤ International Brotherhood of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006.

For information concerning training for glaziers, contact:

➤ National Glass Association, Education and Training Department, 8200 Greensboro Dr., Suite 302, McLean, VA 22102-3881. Internet: <http://www.glass.org>

Hazardous Materials Removal Workers

(O*NET 47-4041.00)

Significant Points

- Working conditions can be difficult, and the use of protective clothing is often required.
- Formal education beyond high school is not required, but a training program leading to a Federal license is mandatory.
- Excellent job opportunities are expected.

Nature of the Work

Increased public awareness and Federal and State regulations are resulting in the removal of hazardous materials from buildings, facilities, and the environment to prevent further contamination of natural resources and to promote public health and safety. Hazardous-materials removal workers identify, remove, package, transport, and dispose of various hazardous materials, including asbestos, lead, and radioactive and nuclear materials. The removal of hazardous materials, or "hazmats," from public places and the environment also is called abatement, remediation, and decontamination.

Hazardous-materials removal workers use a variety of tools and equipment, depending on the work at hand. Equipment ranges from brooms to personal protective suits that completely isolate workers from the hazardous material. Depending on the threat of

contamination, equipment required can include disposable or reusable coveralls, gloves, hard hats, shoe covers, safety glasses or goggles, chemical-resistant clothing, face shields, and hearing protection. Most workers also are required to wear respirators while working to protect them from airborne particles. These respirators range from simple versions that cover only the mouth and nose to self-contained suits with their own air supply.

Asbestos is a material used in the past for fireproofing roofing and flooring, for heat insulation, and for a variety of other uses. While materials containing asbestos rarely are used in buildings anymore, there still are structures containing the material. When embedded in materials, asbestos is fairly harmless; when airborne, however, asbestos can cause several lung diseases, including lung cancer and asbestosis.

Lead was a common building component found in paint and plumbing fixtures and pipes until the late 1970's. Because lead is easily absorbed into the bloodstream, it can travel to vital organs and build up there. The health risks associated with lead poisoning include fatigue, loss of appetite, miscarriage, and learning disabilities and decreased IQ in children. Due to these risks, it has become necessary to remove lead-based products and asbestos from buildings and structures.

Asbestos-abatement and *lead-abatement* workers remove these and other materials from buildings scheduled to be renovated or demolished. They use a variety of hand and power tools, such as vacuums and scrapers, to remove asbestos and lead from surfaces. The vacuums used by asbestos-abatement workers have special, highly efficient filters designed to trap the asbestos, which is later disposed of or stored. During the abatement, special monitors for asbestos and lead content sample the air to protect the workers; lead-abatement workers also wear a personal air monitor that indicates how much lead the worker has been exposed to. Workers also use monitoring devices to identify the asbestos, lead, and other materials that need to be removed from the surfaces of walls and structures.

A typical residential lead-abatement project involves using a chemical to strip the lead-based paint from the walls of the home. Lead-abatement workers apply the compound with a putty knife and allow it to dry. Then, they scrape the hazardous material into an impregnable container for transport and storage. They also use sandblasters and high-pressure water sprayers to remove lead from large structures.

Radioactive materials are classified as either high- or low-level wastes. High-level wastes primarily are nuclear-reactor fuels used to produce electricity. Low-level wastes include any radioactively contaminated protective clothing, tools, filters, medical equipment, and other items. *Decontamination technicians* perform duties similar to janitors and cleaners. They use brooms, mops, and other tools to clean exposed areas and remove exposed items for decontamination or disposal. With experience, these workers can advance to *radiation-protection technician* jobs and use radiation survey meters to locate and evaluate materials, operate high-pressure cleaning equipment for decontamination, and package radioactive materials for transportation or disposal.

Decommissioning and decontamination (D&D) workers remove and treat radioactive materials generated by nuclear facilities and power plants. They use a variety of handtools to break down contaminated items such as "gloveboxes," which are used to process radioactive materials. At decommissioning sites, the workers clean and decontaminate the facility, as well as remove any radioactive or contaminated materials.

Treatment, storage, and disposal (TSD) workers transport and prepare materials for treatment or disposal. To ensure proper treatment of materials, laws require workers in this field to be able to



Hazardous materials removal workers use chemicals to remove lead-based paint.

verify shipping manifests. At incinerator facilities, these workers transport materials from the customer or service center to the incinerator. At landfills, they follow a strict procedure for the processing and storage of hazardous materials. They organize and track the location of items in the fill and may help change the state of a material from liquid to solid in preparation for its storage. These workers typically operate heavy machinery such as forklifts, earthmoving machinery, and large trucks and rigs.

Hazardous-materials removal workers also may be required to construct scaffolding or erect containment areas prior to the abatement or decontamination. Government regulation, in most cases, dictates that hazardous-materials removal workers are closely supervised on the worksite. The standard usually is 1 supervisor to every 10 workers. The work is very structured, planned out sometimes years in advance, and team-oriented. There is a great deal of cooperation among supervisors and coworkers. Due to the nature of the materials being removed, work areas are restricted to licensed hazardous-materials removal workers, thus minimizing exposure to the public.

Working Conditions

Hazardous-materials removal workers face different working conditions depending on their area of expertise. Although many work a standard 40-hour week, overtime and shiftwork is not uncommon, especially in asbestos and lead abatement. Asbestos- and lead-abatement workers tend to work primarily in buildings and other

structures, such as office buildings and schools. Because they are under pressure to complete their work within certain deadlines, workers may experience fatigue. Completing projects frequently requires night and weekend work, because hazardous-materials removal workers often work around the schedules of others. Treatment, storage, and disposal workers are employed primarily at facilities such as landfills, incinerators, boilers, and industrial furnaces. These facilities often are located in remote areas due to the kinds of work being done. As a result, workers employed by treatment, storage, or disposal facilities may commute long distances to work.

Decommissioning and decontamination workers, decontamination technicians, and radiation protection technicians work at nuclear facilities and electrical power plants. These sites, like treatment, storage, and disposal facilities, often are far from urban areas. Workers, who often perform jobs in cramped conditions, may need to use sharp tools to dismantle contaminated objects. A hazardous-materials removal worker must have great self-control and a level head to cope with the daily stress associated with working with hazardous materials.

Hazardous-materials removal employees work in a highly structured environment to minimize danger. Each phase of an operation is planned in advance, and workers are trained to deal with safety breaches and hazardous situations. Crews and supervisors take every precaution to ensure that the worksite is safe. Hazardous-materials removal workers, whether working in asbestos and lead abatement or in radioactive decontamination, must stand, stoop, and kneel for long periods. Some hazardous-materials removal workers must wear fully enclosed personal protective suits for several hours at a time; these suits may be hot and uncomfortable and cause some individuals to experience claustrophobia.

Hazardous-materials removal workers may be required to travel outside their normal working area in order to respond to emergency situations. These emergency cleanups sometimes take several days or weeks to complete, and workers usually are away from home for the duration of the project.

Employment

Hazardous-materials removal workers held about 37,000 jobs in 2000. Nearly half were employed by special trade contractors, primarily in asbestos and lead abatement. Almost a quarter worked in water supply and sanitary services. A small number worked in electric services at nuclear and electric plants as decommissioning and decontamination workers and radiation safety and decontamination technicians.

Training, Other Qualifications, and Advancement

Formal education beyond a high school diploma is not required to become a hazardous materials removal worker. However, workers must be able to perform basic mathematical conversions and calculations, manipulating readings for consideration during the abatement. To perform the job duties, workers also should have good physical strength and manual dexterity.

Because of the nature of the work to be done and the time constraints sometimes involved, employers prefer people who are dependable, prompt, and detail-oriented. Because much of the work is done in buildings, a background in construction is helpful.

Federal regulations require a license to work as a hazardous-materials removal worker. Most employers provide technical training on the job, but a formal 32- to 40-hour training program must be completed to be licensed to work as an asbestos- and lead-abatement worker or a treatment, storage, and disposal worker. The program covers health hazards, personal protective equipment and clothing, site safety, hazard recognition and identification, and decontamination. In some cases, workers will discover one hazardous

material while abating another. If the workers are not licensed to work with the newly discovered material, they cannot continue to work. Many experienced workers opt to take courses in additional disciplines to avoid this situation. Some employers prefer to hire workers licensed in multiple disciplines.

For decommissioning and decontamination workers employed at nuclear facilities, training is more extensive. In addition to the standard 40-hour training course in asbestos, lead, and hazardous waste, workers must take courses on regulations governing nuclear materials and radiation safety. These courses add up to approximately 3 months of training, although most are not taken consecutively. Many agencies, organizations, and companies throughout the country provide training programs that are approved by the U.S. Environmental Protection Agency, the U.S. Department of Energy, and other regulatory bodies. Workers in all fields are required to take refresher courses every year to maintain their license.

Job Outlook

Job opportunities are expected to be excellent for hazardous-materials removal workers, largely due to the numerous openings arising each year as experienced workers leave the occupation. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

The overall employment in this occupation is expected to grow faster than average for all occupations through the year 2010. Employment of the largest group of workers, asbestos- and lead-abatement workers, is expected to grow as fast as other occupations in special trade contractors, but opportunities will be best in lead abatement. Compared with other construction trades occupations, employment of lead-abatement workers is much less affected by slowdowns in the economy.

Employment of decontamination technicians, radiation safety technicians, and decommissioning and decontamination workers is expected to grow in response to increased pressure for safer and cleaner nuclear and electric generator facilities. In addition, the number of closed facilities that need decommissioning may continue to grow due to Federal legislation. These workers also are less affected by fluctuations in the economy because the facilities they work in must operate regardless of the state of the economy.

Opportunities will be best in the private sector as more State and local governments contract out hazardous-materials removal work to private companies.

Earnings

Median hourly earnings of hazardous materials removal workers were \$13.71 in 2000. The middle 50 percent earned between \$11.34 and \$18.56 per hour. The lowest 10 percent earned less than \$9.33 per hour, and the highest 10 percent earned more than \$24.01 per hour. The median hourly earnings in the largest industries employing hazardous materials removal workers in 2000 are shown below.

Miscellaneous special trade contractors	\$13.78
Sanitary services	13.30

According to the limited data available, treatment, storage, and disposal workers usually earn slightly more than asbestos- and lead-abatement workers or decontamination technicians. Decontamination and decommissioning workers and radiation protection technicians, though constituting the smallest group, tend to earn the highest wages.

Related Occupations

Asbestos- and lead-abatement workers share skills with other construction trades workers, including brickmasons, blockmasons, and

stonemasons; cement masons, concrete finishers, segmental pavers, and terrazzo workers; insulation workers; and sheet-metal workers. Treatment, storage, and disposal workers, decommissioning and decontamination workers, and decontamination and radiation safety technicians work closely with plant and system operators, such as power plant operators, distributors, and dispatchers and water and wastewater treatment plant operators.

Sources of Additional Information

For more information on hazardous-materials removal workers, including training information, contact:

► Laborers-AGC Education and Training Fund, 37 Deerfield Rd., P.O. Box 37, Promfret, CT 06259.

Insulation Workers

(O*NET 47-2131.00, 47-2132.00)

Significant Points

- Workers must follow strict safety guidelines to protect themselves from the dangers of insulating irritants.
- Most insulation workers learn informally on the job; others complete formal apprenticeship programs.
- Excellent employment opportunities are expected, resulting largely from job turnover.

Nature of the Work

Properly insulated buildings reduce energy consumption by keeping heat in during the winter and out in the summer. Refrigerated storage rooms, vats, tanks, vessels, boilers, and steam and hot water pipes also are insulated to prevent the wasteful transfer of heat. Insulation workers install the materials used to insulate buildings and equipment.

Insulation workers cement, staple, wire, tape, or spray insulation. When covering a steam pipe, for example, insulation workers measure and cut sections of insulation to the proper length, stretch it open along a cut that runs the length of the material, and slip it over the pipe. They fasten the insulation with adhesive, staples, tape, or wire bands. Sometimes, they wrap a cover of aluminum, plastic, or canvas over it and cement or band the cover in place. Insulation workers may screw on sheet metal around insulated pipes to protect the insulation from weather conditions or physical abuse.

When covering a wall or other flat surface, workers may use a hose to spray foam insulation onto a wire mesh. The wire mesh provides a rough surface to which the foam can cling and adds strength to the finished surface. Workers may then install drywall or apply a final coat of plaster for a finished appearance.

In attics or exterior walls of uninsulated buildings, workers blow in loose-fill insulation. A helper feeds a machine with fiberglass, cellulose, or rock wool insulation while another worker blows the insulation with a compressor hose into the space being filled.

In new construction or major renovations, insulation workers staple fiberglass or rockwool batts to exterior walls and ceilings before drywall, paneling, or plaster walls are put in place. In making major renovations to old buildings or when putting new insulation around pipes and industrial machinery, insulation workers often must first remove the old insulation. In the past, asbestos—now known to cause cancer in humans—was used extensively in walls and ceilings and for covering pipes, boilers, and various industrial equipment. Because of this danger, U.S. Environmental Protection Agency regulations require that asbestos be removed before a



Insulation workers install insulation around pipes and within walls and floors.

building undergoes major renovations or is demolished. When asbestos is present, specially trained workers must remove the asbestos before insulation workers can install the new insulating materials. (See the statement on hazardous-materials removal workers elsewhere in the *Handbook*.)

Insulation workers use common handtools—trowels, brushes, knives, scissors, saws, pliers, and stapling guns. They use power saws to cut insulating materials, welding machines to join sheet metal or secure clamps, and compressors to blow or spray insulation.

Working Conditions

Insulation workers generally work indoors. They spend most of the workday on their feet, either standing, bending, or kneeling. Sometimes, they work from ladders or in tight spaces. The work requires more coordination than strength. Insulation work often is dusty and dirty, and the summer heat can make the insulation worker very uncomfortable. Minute particles from insulation materials, especially when blown, can irritate the eyes, skin, and respiratory system. Workers must follow strict safety guidelines to protect themselves from the dangers of insulating irritants. They keep work areas well-ventilated; wear protective suits, masks, and respirators; and take decontamination showers when necessary.

Employment

Insulation workers held about 53,000 jobs in 2000. The construction industry employed 9 out of 10 of these workers; most worked for insulation or other construction trades contractors. Small numbers of insulation workers held jobs in the Federal Government, in wholesale trade, and in shipbuilding and other manufacturing industries that have extensive installations for power, heating, and cooling. Most worked in urban areas. In less populated areas, carpenters, heating and air-conditioning installers, or drywall installers may do insulation work.

Training, Other Qualifications, and Advancement

Most insulation workers learn their trade informally on the job, although some workers complete formal apprenticeship programs. For entry jobs, insulation contractors prefer high school graduates who are in good physical condition and licensed to drive. High school courses in blueprint reading, shop math, science, sheet-metal layout, woodworking, and general construction provide a helpful background. Applicants seeking apprenticeship positions must have a high school diploma or its equivalent, and be at least 18 years old.

Trainees who learn on the job receive instruction and supervision from experienced insulation workers. Trainees begin with simple tasks, such as carrying insulation or holding material while it is fastened in place. On-the-job training can take up to 2 years, depending on the nature of the work. Learning to install insulation in homes generally requires less training than does insulation application in commercial and industrial settings. As they gain experience, trainees receive less supervision, more responsibility, and higher pay.

In contrast, trainees in formal apprenticeship programs receive in-depth instruction in all phases of insulation. Apprenticeship programs may be provided by a joint committee of local insulation contractors and the local union of the International Association of Heat and Frost Insulators and Asbestos Workers, to which many insulation workers belong. Programs normally consist of 4 years of on-the-job training coupled with classroom instruction, and trainees must pass practical and written tests to demonstrate knowledge of the trade.

Skilled insulation workers may advance to supervisor, shop superintendent, or insulation contract estimator, or they may set up their own insulation business.

Job Outlook

Job opportunities are expected to be excellent for insulation workers, largely due to the numerous openings arising each year as experienced insulation workers move to other occupations. Because there are no strict training requirements for entry, many people with limited skills work as insulation workers for a short time and then move on to other types of work, creating many job openings. Other opportunities will arise from the need to replace workers who leave the labor force. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

In addition to replacement needs, new jobs will arise as employment of insulation workers increases about as fast as the average for all occupations through the year 2010 as a result of growth in residential and nonresidential construction. Demand for insulation workers will be spurred by the continuing concerns about the efficient use of energy to heat and cool buildings, resulting in increased demand for insulation workers in the construction of new residential, industrial, and commercial buildings. In addition, renovation and efforts to improve insulation in existing structures also will increase demand.

Insulation workers in the construction industry may experience periods of unemployment because of the short duration of many construction projects and the cyclical nature of construction activity. Workers employed in industrial plants generally have more stable employment because maintenance and repair must be done on a continuing basis. Most insulation is applied after buildings are enclosed, so weather conditions have less effect on the employment of insulation workers than on that of some other construction occupations.

Earnings

In 2000, median hourly earnings of insulation workers were \$13.05. The middle 50 percent earned between \$9.99 and \$17.00. The lowest 10 percent earned less than \$7.96, and the highest 10 percent earned more than \$24.75. Median hourly earnings in the industries employing the largest numbers of insulation workers in 2000 are shown below:

Miscellaneous special trade contractors	\$13.91
Masonry, stonework, and plastering	12.24

Union workers tend to earn more than nonunion workers. Apprentices start at about one-half of the journeyworker's wage. Insulation workers doing commercial and industrial work earn

substantially more than those working in residential construction, which does not require as much skill.

Related Occupations

Insulation workers combine their knowledge of insulation materials with the skills of cutting, fitting, and installing materials. Workers in occupations involving similar skills include carpenters; carpet, floor, and tile installers and finishers; drywall installers, ceiling tile installers, and tapers; roofers; and sheet metal workers.

Sources of Additional Information

For information about training programs or other work opportunities in this trade, contact a local insulation contractor, a local chapter of the International Association of Heat and Frost Insulators and Asbestos Workers, the nearest office of the State employment service or apprenticeship agency, or:

- International Association of Heat and Frost Insulators and Asbestos Workers, 1776 Massachusetts Ave. NW., Suite 301, Washington, DC 20036. Internet: <http://www.insulators.org>
- National Insulation and Abatement Contractors Association, 99 Canal Center Plaza, Suite 222, Alexandria, VA 22314.
- Insulation Contractors Association of America, 1321 Duke St., Suite 303, Alexandria, VA 22314.

Painters and Paperhangers

(O*NET 47-2141.00, 47-2142.00)

Significant Points

- Working conditions can be hazardous.
- Most workers learn informally on the job as helpers; however, training authorities recommend completion of an apprenticeship program.
- Due to worker turnover, employment prospects should be good.

Nature of the Work

Paint and wall coverings make surfaces clean, attractive, and bright. In addition, paints and other sealers protect outside walls from wear caused by exposure to the weather. Although some people do both painting and paperhanging, each requires different skills.

Painters apply paint, stain, varnish, and other finishes to buildings and other structures. They choose the right paint or finish for the surface to be covered, taking into account durability, ease of handling, method of application, and customers' wishes. Painters first prepare the surfaces to be covered, so that the paint will adhere properly. This may require removing the old coat of paint by stripping, sanding, wire brushing, burning, or water and abrasive blasting. Painters also wash walls and trim to remove dirt and grease, fill nail holes and cracks, sandpaper rough spots, and brush off dust. On new surfaces, they apply a primer or sealer to prepare the surface for the finish coat. Painters also mix paints and match colors, relying on knowledge of paint composition and color harmony. In large paint shops or hardware stores, these functions are automated.

There are several ways to apply paint and similar coverings. Painters must be able to choose the right paint applicator for each job, depending on the surface to be covered, the characteristics of the finish, and other factors. Some jobs need only a good bristle brush with a soft, tapered edge; others require a dip or fountain pressure roller; still others can best be done using a paint sprayer.

Many jobs need several types of applicators. The right tools for each job not only expedite the painter's work but also produce the most attractive surface.

When working on tall buildings, painters erect scaffolding, including "swing stages," scaffolds suspended by ropes, or cables attached to roof hooks. When painting steeples and other conical structures, they use a bosun's chair, a swing-like device.

Paperhangers cover walls and ceilings with decorative wall coverings made of paper, vinyl, or fabric. They first prepare the surface to be covered by applying "sizing," which seals the surface and makes the covering stick better. When redecorating, they may first remove the old covering by soaking, steaming, or applying solvents. When necessary, they patch holes and take care of other imperfections before hanging the new wall covering.

After the surface has been prepared, paperhangers must prepare the paste or other adhesive. Then, they measure the area to be covered, check the covering for flaws, cut the covering into strips of the proper size, and closely examine the pattern to match it when the strips are hung.

The next step is to brush or roll the adhesive onto the back of the covering and to then place the strips on the wall or ceiling, making sure the pattern is matched, the strips are hung straight, and the edges are butted together to make tight, closed seams. Finally, paperhangers smooth the strips to remove bubbles and wrinkles, trim the top and bottom with a razor knife, and wipe off any excess adhesive.



Painting and paperhangers require considerable stamina while bending, stooping, and climbing.

Working Conditions

Most painters and paperhangers work 40 hours a week or less; about 1 out of 10 works part time. Painters and paperhangers must stand for long periods. Their jobs also require a considerable amount of climbing and bending. These workers must have stamina, because much of the work is done with their arms raised overhead. Painters often work outdoors but seldom in wet, cold, or inclement weather.

Painters and paperhangers risk injury from slips or falls off ladders and scaffolds. They sometimes may work with materials that can be hazardous if masks are not worn or if ventilation is poor. Some painting jobs can leave a worker covered with paint.

Employment

Painters and paperhangers held about 518,000 jobs in 2000; most were painters. More than 1 out of every 3 painters and paperhangers work for contractors engaged in new construction, repair, restoration, or remodeling work. In addition, organizations that own or manage large buildings—such as apartment complexes—employ maintenance painters, as do some schools, hospitals, factories, and government agencies.

Self-employed independent painting contractors accounted for 47 percent of all painters and paperhangers. This is significantly greater than the corresponding proportion of building trades workers in general.

Training, Other Qualifications, and Advancement

Painting and paperhanging are learned through apprenticeship or informal, on-the-job instruction. Although training authorities recommend completion of an apprenticeship program as the best way to become a painter or paperhanger, most painters learn the trade informally on the job as a helper to an experienced painter. Few opportunities for informal training exist for paperhangers because few paperhangers have a need for helpers.

The apprenticeship for painters and paperhangers consists of 3 to 4 years of on-the-job training, in addition to 144 hours of related classroom instruction each year. Apprentices receive instruction in color harmony, use and care of tools and equipment, surface preparation, application techniques, paint mixing and matching, characteristics of different finishes, blueprint reading, wood finishing, and safety.

Whether a painter learns the trade through a formal apprenticeship or informally as a helper, on-the-job instruction covers similar skill areas. Under the direction of experienced workers, trainees carry supplies, erect scaffolds, and do simple painting and surface preparation tasks while they learn about paint and painting equipment. As they gain experience, trainees learn to prepare surfaces for painting and paperhanging, to mix paints, and to apply paint and wall coverings efficiently and neatly. Near the end of their training, they may learn decorating concepts, color coordination, and cost-estimating techniques. In addition to learning craft skills, painters must become familiar with safety and health regulations so that their work is in compliance with the law.

Apprentices or helpers generally must be at least 16 years old and in good physical condition. A high school education or its equivalent, with courses in mathematics, usually is required to enter an apprenticeship program. Applicants should have good manual dexterity and color sense.

Painters and paperhangers may advance to supervisory or estimating jobs with painting and decorating contractors. Many establish their own painting and decorating businesses.

Job Outlook

Job prospects should be good, as thousands of painters and paperhangers transfer to other occupations or leave the labor force each

year. Because there are no strict training requirements for entry, many people with limited skills work as painters or paperhangers for a short time and then move on to other types of work. Many fewer openings will occur for paperhangers because the number of these jobs is comparatively small.

In addition to the need to replace experienced workers, new jobs will be created. Employment of painters and paperhangers is expected to grow about as fast as the average for all occupations through the year 2010, reflecting increases in the level of new construction and in the stock of buildings and other structures that require maintenance and renovation. Painting is very labor-intensive and not suitable to the kinds of technological changes that might make workers more productive and thus restrict employment growth.

Jobseekers considering these occupations should expect some periods of unemployment, especially until they become fully skilled. Many construction projects are of short duration, and construction activity is cyclical and seasonal in nature. Remodeling, restoration, and maintenance projects, however, often provide many jobs for painters and paperhangers even when new construction activity declines. The most versatile painters and skilled paperhangers generally are best able to keep working steadily during downturns in the economy.

Earnings

In 2000, median hourly earnings of painters, construction and maintenance, were \$13.10. The middle 50 percent earned between \$10.36 and \$16.81. The lowest 10 percent earned less than \$8.56, and the highest 10 percent earned more than \$22.39. Median hourly earnings in the industries employing the largest numbers of painters in 2000 are shown below:

Painting and paper hanging	\$13.03
Residential building construction	12.79
Real estate operators and lessors	10.95
Real estate agents and managers	10.77
Personnel supply services	10.63

In 2000, median earnings for paperhangers were 15.33. The middle 50 percent earned between \$10.89 and \$19.91. The lowest 10 percent earned less than \$8.04, and the highest 10 percent earned more than \$24.16. Earnings for painters may be reduced on occasion because of bad weather and the short-term nature of many construction jobs. Hourly wage rates for apprentices usually start at 40 to 50 percent of the rate for experienced workers and increase periodically.

Some painters and paperhangers are members of the International Brotherhood of Painters and Allied Trades. Some maintenance painters are members of other unions.

Related Occupations

Painters and paperhangers apply various coverings to decorate and protect wood, drywall, metal, and other surfaces. Other construction occupations in which workers do finishing work include carpenters; carpet, floor, and tile installers and finishers; drywall installers, ceiling tile installers, and tapers; and plasterers and stucco masons.

Sources of Additional Information

For details about painting and paperhanging apprenticeships or work opportunities, contact local painting and decorating contractors, a local of the International Brotherhood of Painters and Allied Trades, a local joint union-management apprenticeship committee, or an office of the State apprenticeship agency or employment service.

For general information about the work of painters and paperhangers, contact:

- International Brotherhood of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006.
For information on training programs, contact:
- Associated Builders and Contractors, 1300 N. 17th St., Arlington, VA 22209. Internet: <http://www.abc.org>
- Painting and Decorating Contractors of America, 3913 Old Lee Highway, Suite 33B, Fairfax, VA, 22030.

Pipelayers, Plumbers, Pipefitters, and Steamfitters

(O*NET 47-2151.00, 47-2152.01, 47-2152.02, 47-2152.03)

Significant Points

- Job opportunities should be excellent because not enough people are seeking training.
- Most workers learn the trade through 4 or 5 years of formal apprenticeship training.
- Pipelayers, plumbers, pipefitters, and steamfitters make up one of the largest and highest paid construction occupations.

Nature of the Work

Most people are familiar with plumbers, who come to their home to unclog a drain or install an appliance. In addition to these activities, however, pipelayers, plumbers, pipefitters, and steamfitters install, maintain, and repair many different types of pipe systems. For example, some systems move water to a municipal water treatment plant and then to residential, commercial, and public buildings. Other systems dispose of waste, provide gas to stoves and furnaces, or supply air-conditioning. Pipe systems in powerplants carry the steam that powers huge turbines. Pipes also are used in manufacturing plants to move material through the production process.

Although pipelaying, plumbing, pipefitting, and steamfitting sometimes are considered a single trade, workers generally specialize in one of the four areas. *Pipelayers* lay clay, concrete, plastic, or cast-iron pipe for drains, sewers, water mains, and oil or gas lines. Before laying the pipe, pipelayers prepare and grade the trenches either manually or with machines. *Plumbers* install and repair the water, waste disposal, drainage, and gas systems in homes and commercial and industrial buildings. Plumbers also install plumbing fixtures—bathtubs, showers, sinks, and toilets—and appliances such as dishwashers and water heaters. *Pipefitters* install and repair both high- and low-pressure pipe systems used in manufacturing, in the generation of electricity, and in heating and cooling buildings. They also install automatic controls that are increasingly being used to regulate these systems. Some pipefitters specialize in only one type of system. *Steamfitters*, for example, install pipe systems that move liquids or gases under high pressure. *Sprinklerfitters* install automatic fire sprinkler systems in buildings.

Pipelayers, plumbers, pipefitters, and steamfitters use many different materials and construction techniques, depending on the type of project. Residential water systems, for example, incorporate copper, steel, and plastic pipe that can be handled and installed by one or two workers. Municipal sewerage systems, on the other hand, are made of large cast-iron pipes; installation normally requires crews of pipefitters. Despite these differences, all pipelayers, plumbers, pipefitters, and steamfitters must be able to follow building plans or blueprints and instructions from supervisors, lay out the job, and work efficiently with the materials and tools of the trade. Computers often are used to create blueprints and plan layouts.



Plumbers install plumbing fixtures such as faucets, sinks, and toilets.

When construction plumbers install piping in a house, for example, they work from blueprints or drawings that show the planned location of pipes, plumbing fixtures, and appliances. They first lay out the job to fit the piping into the structure of the house with the least waste of material and within the confines of the structure. They then measure and mark areas in which pipes will be installed and connected. Construction plumbers also check for obstructions such as electrical wiring and, if necessary, plan the pipe installation around the problem.

Sometimes, plumbers have to cut holes in walls, ceilings, and floors of a house. For some systems, they may hang steel supports from ceiling joists to hold the pipe in place. To assemble a system, plumbers—using saws, pipe cutters, and pipe-bending machines—cut and bend lengths of pipe. They connect lengths of pipe with fittings, using methods that depend on the type of pipe used. For plastic pipe, plumbers connect the sections and fittings with adhesives. For copper pipe, they slide a fitting over the end of the pipe and solder it in place with a torch.

After the piping is in place in the house, plumbers install the fixtures and appliances and connect the system to the outside water or sewer lines. Finally, using pressure gauges, they check the system to ensure that the plumbing works properly.

Working Conditions

Because pipelayers, plumbers, pipefitters, and steamfitters frequently must lift heavy pipes, stand for long periods, and sometimes work in uncomfortable or cramped positions, they need physical strength

as well as stamina. They also may have to work outdoors in inclement weather. In addition, they are subject to possible falls from ladders, cuts from sharp tools, and burns from hot pipes or soldering equipment.

Pipelayers, plumbers, pipefitters, and steamfitters engaged in construction generally work a standard 40-hour week; those involved in maintaining pipe systems, including those who provide maintenance services under contract, may have to work evening or weekend shifts, as well as be on call. These maintenance workers may spend quite a bit of time traveling to and from worksites.

Employment

Pipelayers, plumbers, pipefitters, and steamfitters constitute one of the largest construction occupations, holding about 568,000 jobs in 2000. About 52 percent worked for plumbing, heating, and air conditioning contractors engaged in new construction, repair, modernization, or maintenance work. Others did maintenance work for a variety of industrial, commercial, and government employers. For example, pipefitters were employed as maintenance personnel in the petroleum and chemical industries, where manufacturing operations require the moving of liquids and gases through pipes. About 1 of every 7 pipelayers, plumbers, pipefitters, and steamfitters was self-employed.

Jobs for pipelayers, plumbers, pipefitters, and steamfitters are distributed across the country in about the same proportion as the general population.

Training, Other Qualifications, and Advancement

Virtually all pipelayers, plumbers, pipefitters, and steamfitters undergo some type of apprenticeship training. Many programs are administered by local union-management committees made up of members of the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada, and local employers who are members of either the Mechanical Contractors Association of America, the National Association of Plumbing-Heating-Cooling Contractors, or the National Fire Sprinkler Association.

Nonunion training and apprenticeship programs are administered by local chapters of the Associated Builders and Contractors, the National Association of Plumbing-Heating-Cooling Contractors, the American Fire Sprinkler Association, or the Home Builders Institute of the National Association of Home Builders.

Apprenticeships—both union and nonunion—consist of 4 or 5 years of on-the-job training, in addition to at least 144 hours per year of related classroom instruction. Classroom subjects include drafting and blueprint reading, mathematics, applied physics and chemistry, safety, and local plumbing codes and regulations. On the job, apprentices first learn basic skills, such as identifying grades and types of pipe, using the tools of the trade, and safely unloading materials. As apprentices gain experience, they learn how to work with various types of pipe and how to install different piping systems and plumbing fixtures. Apprenticeship gives trainees a thorough knowledge of all aspects of the trade. Although most pipelayers, plumbers, pipefitters, and steamfitters are trained through apprenticeship, some still learn their skills informally on the job.

Applicants for union or nonunion apprentice jobs must be at least 18 years old and in good physical condition. Apprenticeship committees may require applicants to have a high school diploma or its equivalent. Armed Forces training in pipelaying, plumbing, and pipefitting is considered very good preparation. In fact, persons with this background may be given credit for previous experience when entering a civilian apprenticeship program. Secondary or postsecondary courses in shop, plumbing, general mathematics,

drafting, blueprint reading, computers, and physics also are good preparation.

Although there are no uniform national licensing requirements, most communities require plumbers to be licensed. Licensing requirements vary from area to area, but most localities require workers to pass an examination that tests their knowledge of the trade and of local plumbing codes.

Some pipelayers, plumbers, pipefitters, and steamfitters may become supervisors for mechanical and plumbing contractors; others go into business for themselves.

Job Outlook

Job opportunities are expected to be excellent, as increased demand for skilled pipelayers, plumbers, pipefitters, and steamfitters is expected to outpace the supply of workers trained in this craft. Employment of pipelayers, plumbers, pipefitters, and steamfitters is expected to grow about as fast as the average for all occupations through the year 2010. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Demand for plumbers will stem from building renovation, including the increasing installation of sprinkler systems; repair and maintenance of existing residential systems; and maintenance activities for places having extensive systems of pipes, such as power plants, water and wastewater treatment plants, pipelines, office buildings, and factories. However, the growing use of plastic pipe and fittings, which are much easier to install and repair than other types; increasingly efficient sprinkler systems; and other new technologies will restrict the number of new jobs. In addition to those resulting from employment growth, many positions will become available each year from the need to replace experienced workers who retire or leave the occupation for other reasons.

Traditionally, many organizations with extensive pipe systems have employed their own plumbers or pipefitters to maintain equipment and keep systems running smoothly. But, to reduce labor costs, many of these firms no longer employ a full-time, in-house plumber or pipefitter. Instead, when they need a plumber, they rely on workers provided under service contracts by plumbing and pipefitting contractors.

Construction projects provide only temporary employment. So, when a project ends, pipelayers, plumbers, pipefitters, and steamfitters working on the project may experience bouts of unemployment. Because construction activity varies from area to area, job openings, as well as apprenticeship opportunities, fluctuate with local economic conditions. However, employment of pipelayers, plumbers, pipefitters, and steamfitters generally is less sensitive to changes in economic conditions than is that of some other construction trades. Even when construction activity declines, maintenance, rehabilitation, and replacement of existing piping systems, as well as the increasing installation of fire sprinkler systems, provide many jobs for pipelayers, plumbers, pipefitters, and steamfitters.

Earnings

Pipelayers, plumbers, pipefitters, and steamfitters are among the highest paid construction occupations; in 2000, median hourly earnings of plumbers, pipefitters, and steamfitters were \$18.19. The middle 50 percent earned between \$14.00 and \$24.24. The lowest 10 percent earned less than \$10.71, and the highest 10 percent earned more than \$30.06. Median hourly earnings in the industries employing the largest numbers of plumbers, pipefitters, and steamfitters in 2000 are shown below.

Plumbing, heating, and air-conditioning	\$18.20
Nonresidential building construction	17.80
Heavy construction, except highway	17.26
Local government	17.12
Miscellaneous special trade contractors	16.92

In 2000, median hourly earnings of pipelayers were \$13.20. The middle 50 percent earned between \$10.17 and \$17.71. The lowest 10 percent earned less than \$8.61, and the highest 10 percent earned more than \$23.16.

Apprentices usually begin at about 50 percent of the wage rate paid to experienced pipelayers, plumbers, pipefitters, and steamfitters. Wages increase periodically as skills improve. After an initial waiting period, apprentices receive the same benefits as do experienced pipelayers, plumbers, pipefitters, and steamfitters.

Many pipelayers, plumbers, pipefitters, and steamfitters are members of the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada.

Related Occupations

Other occupations in which workers install and repair mechanical systems in buildings are boilermakers; electricians; elevator installers and repairers; heating, air-conditioning, and refrigeration mechanics and installers; industrial machinery installation, repair, and maintenance workers; sheet-metal workers; and stationary engineers and boiler operators.

Sources of Additional Information

For information about apprenticeships or work opportunities in pipelaying, plumbing, pipefitting, and steamfitting, contact local plumbing, heating, and air-conditioning contractors; a local or State chapter of the National Association of Plumbing, Heating, and Cooling Contractors; a local chapter of the Mechanical Contractors Association; a local chapter of the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada; or the nearest office of your State employment service or apprenticeship agency.

For information about apprenticeship opportunities for pipelayers, plumbers, pipefitters, and steamfitters, contact:

➤ United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry, 901 Massachusetts Ave. NW., Washington, DC 20001.

For more information about training programs for pipelayers, plumbers, pipefitters, and steamfitters, contact:

➤ Associated Builders and Contractors, 1300 N. 17th St., Arlington, VA 22209. Internet: <http://www.abc.org>

➤ National Association of Home Builders, 15th and M St. NW., Washington, DC 20005. Internet: <http://www.nhbi.org>

For general information about the work of pipelayers, plumbers, and pipefitters, contact:

➤ Mechanical Contractors Association of America, 1385 Piccard Dr., Rockville, MD 20850. Internet: <http://www.mcaa.org>

➤ National Association of Plumbing-Heating-Cooling Contractors, 180 S. Washington St., P.O. Box 6808, Falls Church, VA 22040.

For general information about the work of sprinklerfitters, contact:

➤ American Fire Sprinkler Association, Inc., 12959 Jupiter Rd., Suite 142, Dallas, TX 75238-3200. Internet: <http://www.firesprinkler.org>

➤ National Fire Sprinkler Association, Robin Hill Corporate Park, Rt. 22, Box 1000, Patterson, NY 12563. Internet: <http://www.nfsa.org>

Plasterers and Stucco Masons

(O*NET 47-2161.00)

Significant Points

- Plastering is physically demanding.
- Plastering is learned on the job, either through a formal apprenticeship program or by working as a helper.
- Job opportunities are expected to be good, particularly in the South and Southwest.

Nature of the Work

Plastering—one of the oldest crafts in the building trades—is enjoying resurgence in popularity because of the introduction of newer, less costly materials and techniques. *Plasterers* apply plaster to interior walls and ceilings to form fire-resistant and relatively sound-proof surfaces. They also apply plaster veneer over drywall to create smooth or textured abrasion-resistant finishes. In addition, plasterers install prefabricated exterior insulation systems over existing walls—for good insulation and interesting architectural effects—and cast ornamental designs in plaster. Stucco masons apply durable plasters, such as polymer-based acrylic finishes and stucco, to exterior surfaces. Drywall installers, ceiling tile installers, and tapers—who are discussed elsewhere in the *Handbook*—use drywall instead of plaster when erecting interior walls and ceilings.

When plasterers work with interior surfaces such as concrete block and concrete, they first apply a brown coat of gypsum plaster that provides a base, followed by a second, or finish, coat—also called “white coat”—which is a lime-based plaster. When plastering metal lath (supportive wire mesh) foundations, they apply a preparatory, or “scratch,” coat with a trowel. They spread this rich plaster mixture into and over the metal lath. Before the plaster sets, plasterers scratch its surface with a rake-like tool to produce ridges, so that the subsequent brown coat will bond tightly.

Laborers prepare a thick, smooth plaster for the brown coat. Plasterers spray or trowel this mixture onto the surface, then finish by smoothing it to an even, level surface.

For the finish coat, plasterers prepare a mixture of lime, plaster of Paris, and water. They quickly apply this to the brown coat using a “hawk”—a light, metal plate with a handle—trowel, brush, and water. This mixture, which sets very quickly, produces a very smooth, durable finish.

Plasterers also work with a plaster material that can be finished in a single coat. This “thin-coat” or gypsum veneer plaster is made of lime and plaster of Paris and is mixed with water at the jobsite. This plaster provides a smooth, durable, abrasion-resistant finish on interior masonry surfaces, special gypsum baseboard, or drywall prepared with a bonding agent.

Plasterers create decorative interior surfaces as well. They do this by pressing a brush or trowel firmly against a wet plaster surface and using a circular hand motion to create decorative swirls.

For exterior work, stucco masons usually apply stucco—a mixture of Portland cement, lime, and sand—over cement, concrete, masonry, or lath. Stucco may also be applied directly to a wire lath with a scratch coat, followed by a brown coat and then a finish coat. Stucco masons may also embed marble or gravel chips into the finish coat to achieve a pebblelike, decorative finish.

Increasingly, plasterers apply insulation to the exteriors of new and old buildings. They cover the outer wall with rigid foam insulation board and reinforcing mesh, and then trowel on a polymer-based or polymer-modified base coat. They may apply an additional coat of this material with a decorative finish.



Plasterers repair old plaster and install plaster in new construction.

Plasterers sometimes do complex decorative and ornamental work that requires special skill and creativity. For example, they may mold intricate wall and ceiling designs. Following an architect's blueprint, plasterers pour or spray a special plaster into a mold and allow it to set. Workers then remove the molded plaster and put it in place, according to the plan.

Working Conditions

Most plastering jobs are indoors; however, plasterers and stucco masons work outside when applying stucco or exterior wall insulation and decorative finish systems. Sometimes, plasterers work on scaffolds high above the ground.

Plastering is physically demanding, requiring considerable standing, bending, lifting, and reaching overhead. The work can be dusty and dirty, soiling shoes and clothing, and can irritate the skin and eyes.

Employment

Plasterers and stucco masons held about 54,000 jobs in 2000. Most plasterers and stucco masons work on new construction sites, particularly where special architectural and lighting effects are part of the work. Some repair and renovate older buildings. Many plasterers and stucco masons are employed in Florida, California, and the Southwest, where exterior plasters with decorative finishes are very popular.

Most plasterers and stucco masons work for independent contractors. About 1 out of every 6 plasterers and stucco masons is self-employed.

Training, Other Qualifications, and Advancement

Although most employers recommend apprenticeship as the best way to learn plastering, many people learn the trade by working as helpers to experienced plasterers and stucco masons. Those who learn the trade informally as helpers usually start by carrying materials, setting up scaffolds, and mixing plaster. Later, they learn to apply the scratch, brown, and finish coats.

Apprenticeship programs, sponsored by local joint committees of contractors and unions, generally consist of 2 or 3 years of on-the-job training, in addition to at least 144 hours annually of classroom instruction in drafting, blueprint reading, and mathematics for layout work.

In the classroom, apprentices start with a history of the trade and the industry. They also learn about the uses of plaster, estimating materials and costs, and casting ornamental plaster designs. On the job, they learn about lath bases, plaster mixes, methods of plastering, blueprint reading, and safety. They also learn how to use various tools, such as hand and powered trowels, floats, brushes, straightedges, power tools, plaster-mixing machines, and piston-type pumps. Some apprenticeship programs allow individuals to obtain training in related occupations, such as cement masonry and bricklaying.

Applicants for apprentice or helper jobs normally must be at least 17 years old, in good physical condition, and have good manual dexterity. Applicants who have a high school education are preferred. Courses in general mathematics, mechanical drawing, and shop provide a useful background.

Plasterers and stucco masons may advance to supervisors, superintendents, or estimators for plastering contractors or may become self-employed contractors.

Job Outlook

Job opportunities for plasterers and stucco masons are expected to be good through 2010 because many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment of plasterers and stucco masons is expected to increase about as fast as the average for all occupations through the year 2010. In addition to job openings due to rising demand for plastering and stuccowork, jobs will become available as plasterers and stucco masons transfer to other occupations or leave the labor force.

In past years, employment of plasterers declined as more builders switched to drywall construction. This decline has halted, however, and employment of plasterers is expected to continue growing as a result of the appreciation for the durability and attractiveness that troweled finishes provide. Thin-coat plastering—or veneering—in particular is gaining wide acceptance as more builders recognize its ease of application, durability, quality of finish, and fire-retarding qualities. Prefabricated wall systems and new polymer-based or polymer-modified acrylic exterior insulating finishes also are gaining popularity, particularly in the South and Southwest regions of the country. This is not only because of their durability, attractiveness, and insulating properties but also because of their relatively low cost. In addition, plasterers will be needed to renovate plasterwork in old structures and to create special architectural effects, such as curved surfaces, which are not practical with drywall materials.

Most plasterers and stucco masons work in construction, where prospects fluctuate from year to year due to changing economic conditions. Bad weather affects plastering less than other construction trades because most work is indoors. On exterior surfacing jobs, however, plasterers and stucco masons may lose time because materials cannot be applied under wet or freezing conditions. Best employment opportunities should continue to be in Florida, California, and the Southwest, where exterior plaster and decorative finishes are expected to remain popular.

Earnings

In 2000, median hourly earnings of plasterers and stucco masons were \$16.00. The middle 50 percent earned between \$12.41 and \$20.83. The lowest 10 percent earned less than \$9.72, and the top 10 percent earned more than \$26.08.

The median hourly earnings in the largest industries employing plasterers and stucco masons in 2000 were \$16.03 in masonry, stonework, and plastering and \$14.51 in concrete work.

Apprentice wage rates start at about half the rate paid to experienced plasterers and stucco masons. Annual earnings for plasterers and stucco masons and apprentices can be less than the hourly rate would indicate, because poor weather and periodic declines in construction activity can limit worktime.

Many plasterers and stucco masons are members of unions. They are represented by the Operative Plasterers' and Cement Masons' International Association of the United States and Canada, or by the International Union of Bricklayers and Allied Craftsmen.

Related Occupations

Other construction workers who use a trowel as their primary tool include brickmasons, blockmasons, and stonemasons; cement masons, concrete finishers, segmental pavers, and terrazzo workers; and drywall installers, ceiling tile installers, and tapers.

Sources of Additional Information

For information about apprenticeships or other work opportunities, contact local plastering contractors, locals of the unions previously mentioned, a local joint union-management apprenticeship committee, or the nearest office of your State apprenticeship agency or employment service.

For general information about the work of plasterers and stucco masons, contact:

- International Union of Bricklayers and Allied Craftsmen, 815 15th St. NW., Washington, DC 20005. Internet: <http://www.bacweb.org>
- Operative Plasterers' and Cement Masons' International Association of the United States and Canada, 14405 Laurel Place, Suite 300, Laurel, MD 20707.

Roofers

(O*NET 47-2181.00)

Significant Points

- Most roofers acquire their skills informally on the job; some roofers train through 3-year apprenticeship programs.
- Jobs for roofers should be plentiful because the work is hot, strenuous, and dirty, resulting in high job turnover.
- Demand for roofers is less susceptible to downturns in the economy than that for other construction trades because most roofing work consists of repair and reroofing.

Nature of the Work

A leaky roof can damage ceilings, walls, and furnishings. To protect buildings and their contents from water damage, roofers repair and install roofs made of tar or asphalt and gravel; rubber or thermoplastic; metal; or shingles made of asphalt, slate, fiberglass, wood, tile, or other material. Repair and reroofing—replacing old roofs on existing buildings—provide many job opportunities for these workers. Roofers also may waterproof foundation walls and floors.

There are two types of roofs—flat and pitched (sloped). Most commercial, industrial, and apartment buildings have flat or slightly sloping roofs. Most houses have pitched roofs. Some roofers work on both types; others specialize.

Most flat roofs are covered with several layers of materials. Roofers first put a layer of insulation on the roof deck. Over the insulation, they then spread a coat of molten bitumen, a tarlike substance. Next, they install partially overlapping layers of roofing felt—a fabric saturated in bitumen—over the surface. Roofers use a mop to spread hot bitumen over the surface and under the next layer. This seals the seams and makes the surface watertight. Roofers repeat these steps to build up the desired number of layers, called “plies.” The top layer either is glazed to make a smooth finish or has gravel embedded in the hot bitumen to create a rough surface.

An increasing number of flat roofs are covered with a single-ply membrane of waterproof rubber or thermoplastic compounds. Roofers roll these sheets over the roof’s insulation and seal the seams. Adhesive, mechanical fasteners, or stone ballasts hold the sheets in place. The building must be of sufficient strength to hold the ballast.

Most residential roofs are covered with shingles. To apply shingles, roofers first lay, cut, and tack 3-foot strips of roofing felt lengthwise over the entire roof. Then, starting from the bottom edge, they staple or nail overlapping rows of shingles to the roof. Workers measure and cut the felt and shingles to fit intersecting roof surfaces and to fit around vent pipes and chimneys. Wherever two roof surfaces intersect, or shingles reach a vent pipe or chimney, roofers cement or nail flashing-strips of metal or shingle over the joints to make them watertight. Finally, roofers cover exposed nailheads with roofing cement or caulking to prevent water leakage.

Some roofers also waterproof and dampproof masonry and concrete walls and floors. To prepare surfaces for waterproofing, they hammer and chisel away rough spots, or remove them with a rubbing brick, before applying a coat of liquid waterproofing compound. They also may paint or spray surfaces with a waterproofing material, or attach waterproofing membrane to surfaces. When

dampproofing, they usually spray a bitumen-based coating on interior or exterior surfaces.

Working Conditions

Roofing work is strenuous. It involves heavy lifting, as well as climbing, bending, and kneeling. Roofers work outdoors in all types of weather, particularly when making repairs. These workers risk slips or falls from scaffolds, ladders, or roofs, or burns from hot bitumen. In addition, roofs become extremely hot during the summer.

Employment

Roofers held about 158,000 jobs in 2000. Almost all wage and salary roofers worked for roofing contractors. About 1 out of every 4 roofers was self-employed. Many self-employed roofers specialized in residential work.

Training, Other Qualifications, and Advancement

Most roofers acquire their skills informally by working as helpers for experienced roofers. They start by carrying equipment and material, and erecting scaffolds and hoists. Within 2 or 3 months, trainees are taught to measure, cut, and fit roofing materials and, later, to lay asphalt or fiberglass shingles. Because some roofing materials are used infrequently, it can take several years to get experience working on all the various types of roofing applications.

Some roofers train through 3-year apprenticeship programs administered by local union-management committees representing roofing contractors and locals of the United Union of Roofers, Waterproofers, and Allied Workers. The apprenticeship program generally consists of a minimum of 2,000 hours of on-the-job training annually, plus 144 hours of classroom instruction a year in subjects such as tools and their use, arithmetic, and safety. On-the-job training for apprentices is similar to that for helpers, except that the apprenticeship program is more structured. Apprentices also learn to dampproof and waterproof walls.

Good physical condition and good balance are essential for roofers. A high school education, or its equivalent, is helpful, as are courses in mechanical drawing and basic mathematics. Most apprentices are at least 18 years old.

Roofers may advance to supervisor or estimator for a roofing contractor, or become contractors themselves.

Job Outlook

Jobs for roofers should be plentiful through the year 2010, primarily because of the need to replace workers who transfer to other occupations or leave the labor force. Turnover is high—roofing work is hot, strenuous, and dirty, and a significant number of workers treat roofing as a temporary job until something better comes along. Some roofers leave the occupation to go into other construction trades.

Employment of roofers is expected to grow about as fast as the average for all occupations through the year 2010. Roofs deteriorate faster than most other parts of buildings and periodically need to be repaired or replaced. About three-fourths of roofing work is repair and replacement, a higher proportion than in most other construction work. As a result, demand for roofers is less susceptible to downturns in the economy than that for other construction trades. In addition to repair and reroofing work on the growing stock of buildings, new construction of industrial, commercial, and residential buildings will add to the demand for roofers. Jobs should be easiest to find during spring and summer, when most roofing is done.

Earnings

In 2000, median hourly earnings of roofers were \$13.95. The middle 50 percent earned between \$10.72 and \$18.86. The lowest 10



Roofing work is strenuous, involving heavy lifting, climbing, bending, and kneeling.

percent earned less than \$8.68, and the highest 10 percent earned more than \$24.47. The median hourly earnings in 2000 of roofers in the roofing, siding, and sheet metal work industry were \$14.00.

Some roofers are members of the United Union of Roofers, Waterproofers, and Allied Workers.

Apprentices usually start at about 40 percent of the rate paid to experienced roofers and receive periodic raises as they acquire the skills of the trade. Earnings for roofers are reduced on occasion because poor weather often limits the time they can work.

Related Occupations

Roofers use shingles, bitumen and gravel, single-ply plastic or rubber sheets, or other materials to waterproof building surfaces. Workers in other occupations who cover surfaces with special materials for protection and decoration include carpenters; carpet, floor, and tile installers and finishers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; drywall installers, ceiling tile installers, and tapers; and plasterers and stucco masons.

Sources of Additional Information

For information about apprenticeships or job opportunities in roofing, contact local roofing contractors, a local chapter of the roofers union, a local joint union-management apprenticeship committee, or the nearest office of your State employment service or apprenticeship agency.

For information about the work of roofers, contact:

- National Roofing Contractors Association, 10255 W. Higgins Rd., Rosemont, IL 60018-5607. Internet: <http://www.nrca.net>
- United Union of Roofers, Waterproofers, and Allied Workers, 1660 L St. NW., Suite 800, Washington, DC 20036.

Sheet Metal Workers

(O*NET 47-2211.00)

Significant Points

- Two out of 3 jobs are found in the construction industry; about 1 out of 3 is in manufacturing.
- Apprenticeship programs lasting 4 or 5 years are considered the best training.
- Job opportunities should be excellent in construction.

Nature of the Work

Sheet metal workers make, install, and maintain air-conditioning, heating, ventilation, and pollution control duct systems; roofs; siding; rain gutters; downspouts; skylights; restaurant equipment; outdoor signs; and many other products made from metal sheets. They also may work with fiberglass and plastic materials. Although some workers specialize in fabrication, installation, or maintenance, most do all three jobs. In addition to construction-related sheet metal work, some sheet metal workers are employed in the mass production of sheet metal products in manufacturing.

Sheet metal workers first study plans and specifications to determine the kind and quantity of materials they will need. They then measure, cut, bend, shape, and fasten pieces of sheet metal to make ductwork, counter tops, and other custom products. In an increasing number of shops, sheet metal workers use computerized metalworking equipment. This enables them to experiment with different layouts and to select the one that results in the least waste of material. They cut or form parts with computer-controlled saws, lasers, shears, and presses.



Sheet metal workers usually fabricate their products at a shop away from the construction site.

In shops without computerized equipment, and for products that cannot be made on such equipment, sheet metal workers use hand calculators to make the required calculations and use tapes, rulers, and other measuring devices for layout work. They then cut or stamp the parts on machine tools.

Before assembling pieces, sheet metal workers check each part for accuracy using measuring instruments such as calipers and micrometers and, if necessary, finish it by using hand, rotary, or squaring shears and hacksaws. After the parts have been inspected, workers fasten seams and joints together with welds, bolts, cement, rivets, solder, specially formed sheet metal drive clips, or other connecting devices. They then take the parts to the construction site where they further assemble the pieces as they install them. These workers install ducts, pipes, and tubes by joining them end to end and hanging them with metal hangers secured to a ceiling or a wall. They also use shears, hammers, punches, and drills to make parts at the worksite or to alter parts made in the shop.

Some jobs are done completely at the jobsite. When installing a metal roof, for example, sheet metal workers measure and cut the roofing panels that are needed to complete the job. They secure the first panel in place and interlock and fasten the grooved edge of the next panel into the grooved edge of the first. Then, they nail or weld the free edge of the panel to the structure. This two-step process is repeated for each additional panel. Finally, the workers fasten machine-made molding at joints, along corners, and around windows and doors for a neat, finished effect.

In addition to installation, some sheet metal workers specialize in testing, balancing, adjusting, and servicing existing air-conditioning and ventilation systems to make sure they are functioning properly and to improve their energy efficiency.

Sheet metal workers in manufacturing plants make sheet metal parts for products such as aircraft or industrial equipment. Although some of the fabrication techniques used in large-scale manufacturing are similar to those used in smaller shops, the work may be highly automated and repetitive.

Working Conditions

Sheet metal workers usually work a 40-hour week. Those who fabricate sheet metal products work in shops that are well-lighted and well-ventilated. However, they stand for long periods and lift heavy materials and finished pieces. Sheet metal workers must follow safety practices because working around high-speed machines can

be dangerous. They also are subject to cuts from sharp metal, burns from soldering and welding, and falls from ladders and scaffolds. They usually wear safety glasses but must not wear jewelry or loose-fitting clothing that could easily be caught in a machine.

Those performing installation work do considerable bending, lifting, standing, climbing, and squatting, sometimes in close quarters or in awkward positions. Although duct systems and kitchen equipment are installed indoors, the installation of siding, roofs, and gutters involves much outdoor work, requiring sheet metal workers to work in various kinds of weather.

Employment

Sheet metal workers held about 224,000 jobs in 2000. Two-thirds of all sheet metal workers were found in the construction industry. Of those employed in construction, three-fourths worked for plumbing, heating, and air-conditioning contractors; most of the rest worked for roofing and sheet metal contractors. Some worked for other special trade contractors and for general contractors engaged in residential and commercial building. Most of the sheet metal workers outside of construction are found in manufacturing industries, such as the fabricated structural metal products, industrial machinery equipment, and aircraft and parts industries. Some work for the Federal government.

Compared with workers in most construction craft occupations, relatively few sheet metal workers are self-employed.

Training, Other Qualifications, and Advancement

Apprenticeship generally is considered to be the best way to learn this trade. The apprenticeship program consists of 4 or 5 years of on-the-job training and a minimum of 144 hours per year of classroom instruction. Apprenticeship programs provide comprehensive instruction in both sheet metal fabrication and installation. They are administered by local joint committees composed of the Sheet Metal Workers' International Association and local chapters of the Sheet Metal and Air Conditioning Contractors National Association.

On the job, apprentices learn the basics of pattern layout and how to cut, bend, fabricate, and install sheet metal. They begin with basic ductwork and gradually advance to more difficult jobs, such as making more complex ducts, fittings, and decorative pieces. They also use materials such as fiberglass, plastics, and other non-metallic materials.

In the classroom, apprentices learn drafting, plan and specification reading, trigonometry and geometry applicable to layout work, the use of computerized equipment, welding, and the principles of heating, air-conditioning, and ventilating systems. Safety is stressed throughout the program. In addition, apprentices learn the relationship between sheet metal work and other construction work.

Some persons pick up the trade informally, usually by working as helpers to experienced sheet metal workers. Most begin by carrying metal and cleaning up debris in a metal shop while they learn about materials and tools and their uses. Later, they learn to operate machines that bend or cut metal. In time, helpers go out on the jobsite to learn installation. Those who acquire their skills this way often take vocational school courses in mathematics or sheet metal fabrication to supplement their work experience. To be promoted to the journey level, helpers usually must pass the same written examination as apprentices. Most sheet metal workers in large-scale manufacturing receive on-the-job training.

Applicants for jobs as apprentices or helpers should be in good physical condition and have mechanical and mathematical aptitude. Good eye-hand coordination, spatial and form perception, and manual dexterity also are important. Local apprenticeship committees require a high school education or its equivalent. Courses in

algebra, trigonometry, geometry, mechanical drawing, and shop provide a helpful background for learning the trade, as does related work experience obtained in the Armed Services.

It is important for experienced sheet metal workers to keep abreast of new technological developments, such as the growing use of computerized layout and laser cutting machines. Workers often take additional training provided by the union or by their employer, to improve existing skills or to acquire new ones.

Sheet metal workers may advance to supervisory jobs. Some of these workers take additional training in welding and do work that is more specialized. Others go into the contracting business for themselves. Because a sheet metal contractor must have a shop with equipment to fabricate products, this type of contracting business is more expensive to start than other types of construction contracting.

Job Outlook

Job opportunities are expected to be excellent for sheet metal workers in the construction industry and in construction-related sheet metal fabrication, reflecting both rapid employment growth and openings arising each year as experienced sheet metal workers leave the occupation. In addition, many potential workers may prefer work that is less strenuous and that has more comfortable working conditions, thus limiting the number of applicants for sheet metal jobs. Opportunities should be particularly good for individuals who acquire apprenticeship training. Prospects are expected to be better for sheet metal workers in the construction industry than for those in manufacturing because construction is expected to grow faster than the manufacturing industries that employ sheet metal workers.

Employment of sheet metal workers in construction is expected to increase faster than the average for all occupations through 2010, reflecting growth in the demand for sheet metal installations as more industrial, commercial, and residential structures are built. The need to install energy-efficient air-conditioning, heating, and ventilation systems in the increasing stock of old buildings and to perform other types of renovation and maintenance work also should boost employment. In addition, the popularity of decorative sheet metal products and increased architectural restoration are expected to add to the demand for sheet metal workers. On the other hand, average job growth is projected for sheet metal workers in manufacturing.

Sheet metal workers in construction may experience periods of unemployment, particularly when construction projects end and economic conditions dampen construction activity. Nevertheless, employment of sheet metal workers is less sensitive to declines in new construction than is the employment of some other construction workers, such as carpenters. Maintenance of existing equipment—which is less affected by economic fluctuations than is new construction—makes up a large part of the work done by sheet metal workers. Installation of new air-conditioning and heating systems in existing buildings continues during construction slumps, as individuals and businesses adopt more energy-efficient equipment to cut utility bills. In addition, a large proportion of sheet metal installation and maintenance is done indoors, so sheet metal workers usually lose less worktime due to bad weather than other construction workers do.

Earnings

In 2000, median hourly earnings of sheet metal workers employed in all industries were \$15.31. The lowest 10 percent of all sheet metal workers earned less than \$8.90, and the highest 10 percent earned more than \$27.54.

The median hourly earnings of the largest industries employing sheet metal workers in 2000 are shown below.

Federal Government	\$18.85
Plumbing, heating, and air-conditioning	16.06
Roofing, siding, and sheet metal work	15.37
Fabricated structural metal products	14.11
Aircraft and parts	13.47

Apprentices normally start at about 40 percent of the rate paid to experienced workers. As apprentices acquire more skills throughout the course of their training, they receive periodic increases until their pay approaches that of experienced workers. In addition, union workers in some areas receive supplemental wages from the union when they are on layoff or shortened workweeks. Many sheet metal workers are members of the Sheet Metal Workers' International Association.

Related Occupations

To fabricate and install sheet metal products, sheet metal workers combine metalworking skills and knowledge of construction materials and techniques. Other occupations in which workers lay out and fabricate metal products include assemblers and fabricators; machinists; machine setters, operators, and tenders—metal and plastic; and tool and die makers. Construction occupations requiring similar skills and knowledge include glaziers and heating, air-conditioning, and refrigeration mechanics and installers.

Sources of Additional Information

For more information about apprenticeships or other work opportunities, contact local sheet metal contractors or heating, refrigeration, and air-conditioning contractors; a local of the Sheet Metal Workers; a local of the Sheet Metal and Air-Conditioning Contractors National Association; a local joint union-management apprenticeship committee; or the nearest office of your State employment service or apprenticeship agency.

For general information about sheet metal workers, contact:

- International Training Institute for the Sheet Metal and Air-Conditioning Industry, 601 N. Fairfax St., Suite 240, Alexandria, VA 22314.
- Sheet Metal and Air-Conditioning Contractors National Association, 4201 Lafayette Center Dr., Chantilly, VA 20151-1209. Internet: <http://www.smacna.org>
- Sheet Metal Workers International Association, 1750 New York Ave. NW., Washington, DC 20006. Internet: <http://www.smwia.org>

Structural and Reinforcing Iron and Metal Workers

(O*NET 47-2171.00, 47-2221.00)

Significant Points

- Most employers recommend a 3- or 4-year apprenticeship.
- During economic downturns, workers can experience high rates of unemployment.
- The danger of injuries due to falls is great; therefore, those who work at great heights do not work during wet, icy, or extremely windy conditions.

Nature of the Work

Builders use materials made from iron, steel, aluminum, fiberglass, or precast concrete to construct highways, bridges, office and other large buildings, and power transmission towers. These structures have frames made of steel columns, beams, and girders. In addition, reinforced concrete—concrete containing steel bars or wire

fabric—is an important material in buildings, bridges, and other structures, as the steel gives the concrete additional strength. Moreover, metal stairways, catwalks, floor gratings, ladders, window frames, lampposts, railings, fences, and decorative ironwork increase the functionality and attractiveness of these structures. Structural and reinforcing iron and metal workers fabricate, assemble, and install these products. They also repair, renovate, and maintain older buildings and structures, such as manufacturing plants, highways, and bridges.

Even though the primary metal involved in this work is steel, workers often are known as *ironworkers*. Before construction can begin, ironworkers must erect steel frames and assemble the cranes and derricks that move structural steel, reinforcing bars, buckets of concrete, lumber, and other materials and equipment around the construction site. The structural metal arrives at the construction site in sections. There, it is lifted into position by a crane. Ironworkers then connect the sections and set the cables to do the hoisting.

Once this job has been completed, workers begin to connect steel columns, beams, and girders according to blueprints and instructions from supervisors and superintendents. Structural steel, reinforcing rods, and ornamental iron generally come to the construction site ready for erection—cut to the proper size, with holes drilled for bolts and numbered for assembly.

Ironworkers at the construction site unload and stack the prefabricated steel so that it can be hoisted easily when needed. To hoist the steel, metal workers attach cables from a crane or derrick. One worker directs the hoist operator with hand signals. Another worker



Ironworkers connect sections of structural steel.

holds a rope (tag line) attached to the steel to prevent it from swinging. The crane or derrick hoists steel into place in the framework, where several workers, using spud wrenches, position the steel with connecting bars and jacks. Workers using drift pins or the handle of a spud wrench—a long wrench with a pointed handle—align the holes in the steel with the holes in the framework. Then, they temporarily bolt the piece in place; check vertical and horizontal alignment with plumb bobs, laser equipment, transits, or levels; and bolt or weld the piece permanently in place.

Reinforcing iron and rebar workers set the bars in the forms that hold concrete, following blueprints showing the location, size, and number of reinforcing bars (rebar). They then fasten the bars together by tying wire around them with pliers. When reinforcing floors, workers place blocks under the rebar to hold the bars off the deck. Although these materials usually arrive ready to use, ironworkers occasionally must cut bars with metal shears or acetylene torches, bend them by hand or machine, or weld them with arc-welding equipment. Some concrete is reinforced with welded wire fabric. Using hooked rods, workers cut and fit the fabric and, while a concrete crew places the concrete, metal workers properly position the fabric in the concrete. Post-tensioning is another technique used in reinforcing concrete; workers substitute cables for reinforcing bars. When the concrete is poured, the ends of the cables are left exposed. After the concrete dries, ironworkers tighten the cable. Post-tensioning allows designers to create larger open areas in a building because supports can be placed further apart. This technique is commonly employed in parking garages and arenas.

Ornamental ironworkers install elevator shafts, stairs, curtain walls (the nonstructural walls and window frames of many large buildings), and other ornamentation pieces after the structure of the building has been completed. As they hoist pieces into position, ornamental ironworkers check that the pieces are properly fitted and aligned before bolting, brazing, or welding them for a secure fit.

Working Conditions

Structural and reinforcing iron and metal workers usually work outside in all kinds of weather. However, those who work at great heights do not work during wet, icy, or extremely windy conditions. Because the danger of injuries due to falls is great, ironworkers use safety devices such as safety belts, scaffolding, and nets to reduce risk.

Some ironworkers fabricate structural metal in fabricating shops, which usually are located away from the construction site. They are covered in the statement on assemblers and fabricators found elsewhere in the *Handbook*.

Employment

Structural and reinforcing iron and metal workers held about 111,000 jobs in 2000. About half worked for structural steel erection contractors. Most of the remainder worked for contractors specializing in the construction of homes; factories; commercial buildings; churches; schools; bridges and tunnels; and water, sewer, communications, and power lines.

Structural and reinforcing iron and metal workers are employed in all parts of the country, but most work in metropolitan areas, where most commercial and industrial construction takes place.

Training, Other Qualifications, and Advancement

Most employers recommend a 3- or 4-year apprenticeship, consisting of on-the-job training and evening classroom instruction, as the best way to learn this trade. Apprenticeship programs usually are administered by committees made up of representatives of local unions of the International Association of Bridge, Structural,

Ornamental and Reinforcing Iron Workers or the local chapters of contractors' associations.

Ironworkers must be at least 18 years old. A high school diploma may be preferred by employers and may be required by some local apprenticeship committees. High school courses in general mathematics, mechanical drawing, and shop are helpful. Because materials used in iron working are heavy and bulky, metal workers must be in good physical condition. They also need good agility, balance, eyesight, and depth perception to safely work at great heights on narrow beams and girders. Ironworkers should not be afraid of heights or suffer from dizziness.

In the classroom, apprentices study blueprint reading; mathematics for layout work; the basics of structural erecting, rigging, reinforcing, welding, and burning; ornamental erection; and assembling. Apprentices also study the care and safe use of tools and materials. On the job, apprentices work in all aspects of the trade, such as unloading and storing materials at the job site, rigging materials for movement by crane or derrick, connecting structural steel, and welding.

Some ironworkers learn the trade informally on the job without completing an apprenticeship. These workers generally do not receive classroom training, although some large contractors have extensive training programs. On-the-job trainees usually begin by assisting experienced ironworkers by doing simple jobs, such as carrying various materials. With experience, trainees perform more difficult tasks like cutting and fitting different parts; however, learning through work experience alone may not provide training as complete as an apprenticeship program and usually takes longer.

Some experienced workers are promoted to supervisor. Others may go into the contracting business for themselves.

Job Outlook

Employment of structural and reinforcing iron and metal workers is expected to rise about as fast as the average for all occupations through the year 2010, largely based on the continued growth in industrial and commercial construction. The rehabilitation, maintenance, and replacement of a growing number of older buildings, factories, power plants, and highways and bridges is expected to create employment opportunities. While some new jobs will arise, most openings will result from the need to replace experienced ironworkers who transfer to other occupations or leave the labor force.

The number of job openings fluctuates from year to year as economic conditions and the level of construction activity change. During economic downturns, ironworkers can experience high rates of unemployment. Similarly, job opportunities for ironworkers may vary widely by geographic area. Job openings for ironworkers usually are more abundant during the spring and summer months, when the level of construction activity increases.

Earnings

In 2000, median hourly earnings of structural iron and steel workers in all industries were \$17.92. The middle 50 percent earned between \$13.34 and \$24.16. The lowest 10 percent earned less than \$10.05, and the highest 10 percent earned more than \$29.62. In 2000, median hourly earnings of reinforcing iron and rebar workers in all industries were \$16.78. The middle 50 percent earned between \$12.57 and \$23.64. The lowest 10 percent earned less than \$9.90, and the highest 10 percent earned more than \$27.86. Median hourly earnings in the industries employing the largest number of structural iron and steel workers in 2000 were:

Miscellaneous special trade contractors	\$19.59
Heavy construction, except highway	17.55
Nonresidential building construction	15.86
Fabricated structural metal products	13.71

Many workers in this trade are members of the International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers. According to the union, average hourly earnings, including benefits, for structural and reinforcing metal workers who belonged to a union and worked full time ranged between \$18 and \$50 in 2000. Structural and reinforcing iron and metal workers in New York, Boston, San Francisco, Chicago, Los Angeles, Philadelphia, and other large cities received the highest wages.

Apprentices generally start at about 50 to 60 percent of the rate paid to experienced journey workers. They receive periodic increases throughout the course of the apprenticeship program, as they acquire the skills of the trade, until their pay approaches that of experienced workers.

Earnings for ironworkers may be reduced on occasion because work can be limited by bad weather, the short-term nature of construction jobs, and economic downturns.

Related Occupations

Structural and reinforcing iron and metal workers play an essential role in erecting buildings, bridges, highways, powerlines, and other structures. Others who also work on these construction jobs include assemblers and fabricators; boilermakers; civil engineers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; construction managers; and welding, soldering, and brazing workers.

Sources of Additional Information

For more information on apprenticeships or other work opportunities, contact local general contractors; a local of the International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers Union; a local ironworkers' joint union-management apprenticeship committee; a local or State chapter of the Associated Builders and Contractors; or the nearest office of your State employment service or apprenticeship agency

For apprenticeship information, contact:

► International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers, Apprenticeship Department, 1750 New York Ave. NW., Suite 400, Washington, DC 20006.

For general information about ironworkers, contact:

► The Associated General Contractors of America, 333 John Carlyle St., Suite 200, Alexandria, VA 22314.

Welding, Soldering, and Brazing Workers

(O*NET 51-4121.01, 51-4121.02, 51-4121.03, 51-4121.04, 51-4121.05, 51-4122.01, 51-4122.02, 51-4122.03, 51-4122.04)

Significant Points

- Job prospects should be excellent.
- Training ranges from a few weeks of school or on-the-job training for low-skilled positions to several years of combined school and on-the-job training for highly skilled jobs.

Nature of the Work

Welding is the most common way of permanently joining metal parts. In this process, heat is applied to metal pieces, melting and fusing them to form a permanent bond. Because of its strength, welding is used in shipbuilding, automobile manufacturing and repair, aerospace applications, and thousands of other manufacturing activities. Welding also is used to join beams when constructing buildings,

bridges, and other structures, and to join pipes in pipelines, power plants, and refineries.

Welders use many types of welding equipment set up in a variety of positions, such as flat, vertical, horizontal, and overhead. They may perform manual welding, in which the work is entirely controlled by the welder, or semiautomatic welding, in which the welder uses machinery, such as a wire feeder, to help in performing welding tasks.

Arc welding is the most common type of welding. Standard arc welding involves two large metal alligator clips that are carrying a strong electrical current. One clip is attached to any part of the workpiece being welded. The second clip is connected to a thin welding rod. When the rod touches the workpiece, a powerful electrical circuit is created. The massive heat created by the electrical current causes both the workpiece and the steel core of the rod to melt together, cooling quickly to form a solid bond. During welding, the flux that surrounds the rod's core vaporizes, forming an inert gas that serves to protect the weld from atmospheric elements that might weaken it. Two common advanced types of arc welding are Gas Tungsten Arc (TIG) and Gas Metal Arc (MIG) welding. Instead of welding rods, these welding systems use a spool of continuously fed wire, which allows the welder to weld longer stretches without stopping to replace the rod. Instead of using gas flux surrounding the rod, TIG and MIG protect the initial weld from the environment by blowing inert gas onto the weld.

Like arc welding, soldering and brazing use metal to join two pieces of metal. However, the metal added during the process has melting point lower than that of the workpiece, so only the added metal is melted, not the workpiece. Soldering uses metals with a melting point below 800 degrees Fahrenheit; brazing uses metals with a melting point above 800 degrees Fahrenheit. Because soldering and brazing do not melt the workpiece, these processes normally do not create distortions or weaknesses in the workpiece that can occur with welding. Soldering commonly is used to join electrical, electronic, and other small metal parts. Brazing produces a stronger joint than does soldering, and often is used to join metals other than steel, such as brass parts.

Skilled welding, soldering, and brazing workers generally plan work from drawings or specifications or use their knowledge of fluxes and base metals to analyze parts. These workers then select and set up welding equipment and examine welds, to ensure that they meet standards or specifications. Some welders have more limited duties, however. They perform routine jobs that already



A relatively small proportion of welding, soldering, and brazing workers are in construction.

have been planned and laid out and do not require extensive knowledge of welding techniques.

Automated welding is used in an increasing number of production processes. In these instances, a machine or robot performs the welding tasks while monitored by a welding machine operator. Welding, soldering, and brazing machine setters, operators, and tenders follow specified layouts, work orders, or blueprints. Operators must load parts correctly and constantly monitor the machine to ensure that it produces the desired bond.

The work of arc, plasma, and oxy-gas cutters is closely related to that of welders. However, instead of joining metals, cutters use the heat from an electric arc, a stream of ionized gas, or burning gases to cut and trim metal objects to specific dimensions. Cutters also dismantle large objects, such as ships, railroad cars, automobiles, buildings, or aircraft. Some operate and monitor cutting machines similar to those used by welding machine operators. Plasma cutting has been increasing in popularity because, unlike other methods, it can cut a wide variety of metals, including stainless steel, aluminum, and titanium.

Working Conditions

Welding, soldering, and brazing workers often are exposed to a number of potential hazards, including the intense light created by the arc, hazardous fumes, and burns. In the interests of safety, they wear safety shoes, goggles, hoods with protective lenses, and other devices designed to prevent burns and eye injuries and to protect them from falling objects. They normally work in well-ventilated areas to limit their exposure to fumes. Automated welding, soldering, and brazing machine operators are not exposed to as many dangers, however, and a face shield or goggles usually provide adequate protection for these workers.

Welders and cutters may work outdoors, often in inclement weather, or indoors, sometimes in a confining area designed to contain sparks and glare. When outdoors, they may work on a scaffold or platform high off the ground. In addition, they may be required to lift heavy objects and work in a variety of awkward positions, having to make welds while bending, stooping, or working overhead.

Although about half of welders, solderers, and brazers work a 40-hour week, overtime is common, and some welders work up to 70 hours per week. Welders also may work in shifts as long as 12 hours. Some welders, solderers, brazers, and machine operators work in factories that operate around-the-clock.

Employment

Welding, soldering, and brazing workers held about 521,000 jobs in 2000. Of these jobs, 3 of every 4 were found in manufacturing and services. Most manufacturing jobs were in the transportation equipment, industrial machinery and equipment, or fabricated metal products industries. Services industry jobs were mainly in repair shops and personnel supply agencies. Most jobs for welding, soldering, and brazing machine setters, operators, and tenders were found in manufacturing industries, primarily those producing fabricated metal products, motor vehicles, and construction and related machinery.

Training, Other Qualifications, and Advancement

Training for welding, soldering, and brazing workers can range from a few weeks of school or on-the-job training for low-skilled positions to several years of combined school and on-the-job training for highly skilled jobs. Formal training is available in high schools, vocational schools, and postsecondary institutions, such

as vocational-technical institutes, community colleges, and private welding schools. The Armed Forces operate welding schools as well. Some employers provide training. Courses in blueprint reading, shop mathematics, mechanical drawing, physics, chemistry, and metallurgy are helpful. Knowledge of computers is gaining in importance, especially for welding, soldering, and brazing machine operators, who are becoming responsible for the programming of computer-controlled machines, including robots.

Some welders become certified, a process whereby the employer sends a worker to an institution, such as an independent testing lab or technical school, to weld a test specimen to specific codes and standards required by the employer. Testing procedures are based on the standards and codes set by one of several industry associations with which the employer may be affiliated. If the welding inspector at the examining institution determines that the worker has performed according to the employer's guidelines, the inspector will then certify the welder being tested as able to work with a particular welding procedure.

Welding, soldering, and brazing workers need good eyesight, hand-eye coordination, and manual dexterity. They should be able to concentrate on detailed work for long periods and be able to bend, stoop, and work in awkward positions. In addition, welders increasingly need to be willing to receive training and perform tasks in other production jobs.

Welders can advance to more skilled welding jobs with additional training and experience. For example, they may become welding technicians, supervisors, inspectors, or instructors. Some experienced welders open their own repair shops.

Job Outlook

Job prospects should be excellent for skilled candidates, as many potential entrants who have the educational and personal qualifications to acquire the necessary skills may prefer to attend college or may prefer work that has more comfortable working conditions. Employment of welding, soldering, and brazing workers is expected to grow about as fast as the average for all occupations over the 2000-10 period. In addition, many openings will arise as workers retire or leave the occupation for other reasons.

The major factor affecting employment of welders is the health of the industries in which they work. Because almost every manufacturing industry uses welding at some stage of manufacturing or in the repair and maintenance of equipment, a strong economy will keep demand for welders high. A downturn affecting industries such as auto manufacturing, construction, or petroleum, however, would have a negative impact on the employment of welders in those areas, and could cause some layoffs. Levels of government funding for infrastructure repairs and improvements also are expected to be an important determinant of the future number of welding jobs.

Regardless of the state of the economy, the pressures to improve productivity and hold down labor costs are leading many companies to invest more in automation, especially computer-controlled and robotically-controlled welding machinery. This may affect the demand for low-skilled manual welding, soldering, and brazing workers because the jobs that are currently being automated are the simple, repetitive ones. The growing use of automation, however, should increase demand for highly skilled welding, soldering, and brazing machine setters, operators, and tenders. Welders working on construction projects or in equipment repair will not be affected by technology change to the same extent that other welders are, because their jobs are not as easily automated.

Technology is helping to improve welding, creating more uses for welding in the workplace and expanding employment opportunities.

For example, new ways are being developed to bond dissimilar materials and nonmetallic materials, such as plastics, composites, and new alloys. Also, laser beam and electron beam welding, new fluxes, and other new technologies and techniques are improving the results of welding, making it applicable to a wider assortment of jobs. Improvements in technology also have boosted welding productivity, making it more competitive with other methods of joining metals.

Earnings

Median hourly earnings of welders, cutters, solderers, and brazers were \$13.13 in 2000. The middle 50 percent earned between \$10.74 and \$16.37. The lowest 10 percent had earnings of less than \$8.86, while the top 10 percent earned over \$20.74. Median hourly earnings in the industries employing the largest numbers of welders, cutters, solderers, and brazers in 2000 were:

Construction and related machinery	\$13.51
Motor vehicles and equipment	13.43
Fabricated structural metal products	12.91
Miscellaneous repair shops	12.33
Personnel supply services	10.55

Median hourly earnings of welding, soldering, and brazing machine setters, operators, and tenders were \$13.09 in 2000. The middle 50 percent earned between \$10.41 and \$16.83. The lowest 10 percent had earnings of less than \$8.64, while the top 10 percent earned over \$23.32. Median hourly earnings in the industries employing the largest numbers of welding machine operators in 2000 were:

Motor vehicles and equipment	\$16.16
Construction and related machinery	13.72
Fabricated structural metal products	12.77

Many welders belong to unions. Among these are the International Association of Machinists and Aerospace Workers; the International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers and Helpers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada; and the United Electrical, Radio, and Machine Workers of America.

Related Occupations

Welding, soldering, and brazing workers are skilled metal workers. Other metal workers include machinists; machine setters, operators, and tenders—metal and plastic; computer-control programmers and operators; tool and die makers; sheet metal workers; and boilermakers.

Sources of Additional Information

For information on training opportunities and jobs for welding, soldering, and brazing workers, contact local employers, the local office of the State employment service, or schools providing welding, soldering, or brazing training.

Information on careers in welding is available from:

► American Welding Society, 550 N.W. Lejeune Rd., Miami, FL 33126-5699. Internet: <http://www.aws.org>

Woodworkers

(O*NET 51-7011.00, 51-7021.00, 51-7031.00, 51-7032.00, 51-7041.01, 51-7041.02, 51-7042.01, 51-7042.02, 51-7099.99)

Significant Points

- Most woodworkers are trained on the job; basic machine operations may be learned in a few months, but becoming a skilled woodworker often requires 2 or more years.
- Employment is expected to grow more slowly than average—reflecting relatively slow growth among lesser skilled woodworkers.
- Job prospects will be best for highly skilled workers and those with knowledge of computerized numerical control machine tool operation.

Nature of the Work

In spite of the development of sophisticated plastics and other materials, the demand for wood products continues unabated. Helping to meet this demand are woodworkers. Woodworkers are found in industries that produce wood, such as sawmills and plywood mills; in industries that use wood to produce furniture, kitchen cabinets, musical instruments, and other fabricated wood products; or in small shops that make architectural woodwork, furniture, and many other specialty items.

All woodworkers are employed at some stage of the process through which logs of wood are transformed into finished products. Some of these workers produce the structural elements of buildings; others mill hardwood and softwood lumber; still others assemble finished wood products. They operate machines that cut, shape, assemble, and finish raw wood to make the doors, windows, cabinets, trusses, plywood, flooring, paneling, molding, and trim that are components of most homes. Others may fashion home accessories, such as beds, sofas, tables, dressers, and chairs. In addition to these household goods, woodworkers also make sporting goods, including baseball bats, racquets, and oars, as well as musical instruments, toys, caskets, tool handles, and thousands of other wooden items.

Production woodworkers set up, operate, and tend woodworking machines such as power saws, planers, sanders, lathes, jointers, and routers that cut and shape components from lumber, plywood, and other wood products. In sawmills, *sawing machine operators and tenders* set up, operate, or tend wood sawing machines that cut logs into planks, timbers, or boards. In plants manufacturing wood products, woodworkers first determine the best method of shaping and assembling parts working from blueprints, supervisors' instructions, or shop drawings that woodworkers themselves produce. Before cutting, they often must measure and mark the materials. They verify dimensions and may trim parts using hand tools such as planes, chisels, wood files, or sanders to insure a tight fit. *Woodworking machine operators and tenders* set up, operate, or tend a specific woodworking machine such as drill presses, lathes, shapers, routers, sanders, planers, and wood-nailing machines. Lower skilled operators may merely press a switch on a woodworking machine and monitor the automatic operation whereas more highly skilled operators set up equipment, cut and shape wooden parts, and verify dimensions using a template, caliper, or rule.

The next step in the manufacturing process is the production of subassemblies using fasteners and adhesives. The pieces then are brought together to form a complete unit. The product is then finish sanded, stained, and, if necessary, coated with a sealer, such as



Furniture and fixtures manufacturing firms employ 1 in 4 woodworkers.

lacquer or varnish. Woodworkers may perform this work in teams or be assisted by a helper.

Woodworkers have been greatly affected by the introduction of computer-controlled machinery. This technology has raised worker productivity by allowing one operator to simultaneously tend a greater number of machines. With computerized numerical controls (CNC), an operator can program a machine to perform a sequence of operations automatically, resulting in greater precision and reliability. The integration of computers with equipment has improved production speeds and capabilities, simplified setup and maintenance requirements, and increased the demand for workers with computer skills.

While this costly equipment has had a great impact on workers in the largest, most efficient firms, precision or custom woodworkers—who generally work in smaller firms—have continued to employ the same production techniques they have used for many years. Workers such as *cabinetmakers and bench carpenters*; *model makers and patternmakers*; and *furniture finishers* work on a customized basis, often building one-of-a-kind items. These highly skilled precision woodworkers usually perform a complete cycle of tasks, cutting, shaping, preparing surfaces, and assembling prepared parts of complex wood components into a finished wood product. For this reason, these workers normally need substantial training and an ability to work from detailed instructions and specifications. In addition, they often are required to exercise independent judgment when undertaking an assignment.

Working Conditions

Working conditions vary by industry and specific job duties. In primary industries, such as logging and sawmills, working conditions are physically demanding, due to the handling of heavy, bulky material. Workers in these industries also may encounter excessive noise and dust and other air pollutants. However, the use of ear-plugs and respirators may partially alleviate these problems. Also, rigid adherence to safety precautions minimizes risk of injury from contact with rough wood stock, sharp tools, and power equipment. The risk of injury also is lowered by the installation of computer-controlled equipment, which reduces the physical labor and hands-on contact with machinery.

In secondary industries, such as furniture and kitchen cabinet manufacturing, working conditions also depend on the industry and the particular job. Employees who operate machinery often must wear ear and eye protection, follow operating safety instructions,

and use safety shields or guards to prevent accidents. Those who work in the finishing area must either be provided with an appropriate dust or vapor mask, a complete protective safety suit, or work in a finishing environment that removes all vapors and particulate matter from the atmosphere. Prolonged standing, lifting, and fitting heavy objects are common characteristics of the job.

Employment

Woodworkers held about 409,000 jobs in 2000. Self-employed woodworkers, mostly cabinetmakers and furniture finishers, accounted for 10 percent of these jobs. Employment among detailed woodworking occupations was distributed as follows:

Cabinetmakers and bench carpenters	159,000
Woodworking machine setters, operators, and tenders, except sawing	103,000
Sawing machine setters, operators, and tenders, wood	57,000
Furniture finishers	45,000
All other woodworkers	35,000
Model makers and patternmakers, wood	10,000

More than 7 out of 10 woodworkers were employed in manufacturing industries. Among these woodworkers, 27 percent were found in establishments fabricating household and office furniture and fixtures and 40 percent worked in lumber and wood products, manufacturing a variety of raw, intermediate, and finished wood stock. Wholesale and retail lumber dealers, furniture stores, reupholstery and furniture repair shops, and construction firms also employ woodworkers.

Woodworking jobs are found throughout the country. However, production jobs are concentrated in the South and Northwest, close to the supply of wood, whereas furniture makers are more prevalent in the East. Custom shops can be found everywhere, but generally are concentrated in or near highly populated areas.

Training, Other Qualifications, and Advancement

Most woodworkers are trained on the job, picking up skills informally from experienced workers. Some acquire skills through vocational education or by working as carpenters on construction jobs. Others may attend colleges or universities that offer training in areas including wood technology, furniture manufacturing, wood engineering, and production management. These programs prepare students for positions in production, supervision, engineering, and management.

Beginners usually observe and help experienced machine operators. They may supply material to or remove fabricated products from machines. Trainees also do simple machine operating jobs, while at first closely supervised by experienced workers. As beginners gain experience, they perform more complex jobs with less supervision. Some may learn to read blueprints, set up machines, and plan the sequence of the work. Most woodworkers learn basic machine operations and job tasks in a few months, but becoming a skilled woodworker often requires 2 or more years.

Employers increasingly seek applicants with a high school diploma or the equivalent, because of the growing sophistication of machinery and the constant need for retraining. Persons seeking woodworking jobs can enhance their employment and advancement prospects by completing high school and receiving training in mathematics, science, and computer applications. Other important qualities for entrants in this occupation include mechanical ability, manual dexterity, and the ability to pay attention to detail.

Advancement opportunities often are limited and depend upon availability, seniority, and a worker's skills and initiative. Sometimes experienced woodworkers become inspectors or supervisors responsible for the work of a group of woodworkers. Production

workers often can advance into these positions by assuming additional responsibilities and by attending workshops, seminars, or college programs. Those who are highly skilled may set up their own woodworking shops.

Job Outlook

Overall employment of woodworkers is expected to grow more slowly than the average for all occupations through the year 2010—reflecting relatively slow growth among lesser-skilled woodworking machine setters, operators, and tenders, except sawing, and furniture finishers. On the other hand, employment of higher-skilled woodworkers—including model makers and patternmakers, wood; sawing machine setters, operators, and tenders, wood; and cabinetmakers and bench carpenters—is expected to grow about as fast as the average for all occupations. In addition, thousands of openings will arise each year because of the need to replace experienced woodworkers who transfer to other occupations or leave the labor force.

Demand for woodworkers will stem from increases in population, personal income, and business expenditures, in addition to the continuing need for repair and renovation of residential and commercial properties. Therefore, opportunities should be particularly good for woodworkers who specialize in such items as moldings, cabinets, stairs, and windows. Due to increasingly automated manufacturing processes, prospects will be best for highly skilled woodworkers with knowledge of CNC machine tool operation.

Several factors may limit the growth of woodworking occupations. Technological advances, like robots and CNC machinery, will continue to increase productivity among woodworkers, preventing employment from rising as fast as the demand for wood products, particularly in the mills and manufacturing plants where many processes can be automated. In addition, some jobs in the United States will be lost as imports continue to grow and as U.S. firms move some production to other countries. Also, the demand for wood may be reduced somewhat, as materials such as metal, plastic, and fiberglass continue to be used in many products as alternatives to wood. Environmental measures designed to control various pollutants used in, or generated by, woodworking processes also may adversely impact employment.

Employment in all woodworking specialties is highly sensitive to economic cycles. During economic downturns, workers are subject to layoffs or a reduction in hours.

Earnings

Median hourly earnings of cabinetmakers and bench carpenters were \$10.83 in 2000. The middle 50 percent earned between \$8.69 and \$13.72. The lowest 10 percent earned less than \$7.24, and the highest 10 percent earned more than \$17.21. Median hourly earnings in the industries employing the largest numbers of cabinetmakers and bench carpenters in 2000 are shown below:

Partitions and fixtures	\$12.24
Furniture and homefurnishings stores	11.15
Millwork, plywood, and structural members	10.75
Household furniture	9.83

Median hourly earnings of sawing machine setters, operators, and tenders, wood were \$10.23 in 2000. The middle 50 percent earned between \$8.40 and \$12.60. The lowest 10 percent earned less than \$7.12, and the highest 10 percent earned more than \$15.36. Median hourly earnings in the industries employing the largest numbers of sawing machine setters, operators, and tenders, wood in 2000 are shown below:

Sawmills and planing mills	\$10.56
Millwork, plywood, and structural members	10.36
Household furniture	9.88

Median hourly earnings of woodworking machine setters, operators, and tenders, except sawing were \$10.00 in 2000. The middle 50 percent earned between \$8.19 and \$12.32. The lowest 10 percent earned less than \$6.95, and the highest 10 percent earned more than \$14.88. Median hourly earnings in the industries employing the largest numbers of woodworking machine setters, operators, and tenders, except sawing in 2000 are shown below:

Millwork, plywood, and structural members	\$10.36
Household furniture	10.05
Sawmills and planing mills	9.83
Miscellaneous wood products	9.37
Wood containers	8.30

In 2000, median hourly earnings were \$10.34 for furniture finishers and \$9.48 for all other woodworkers.

Some woodworkers, such as those in logging or sawmills who are engaged in processing primary wood and building materials, are members of the International Association of Machinists. Others belong to the United Brotherhood of Carpenters and Joiners of America.

Related Occupations

Carpenters also work with wood. In addition, many woodworkers follow blueprints and drawings and use machines to shape and form raw wood into a final product. Workers who perform similar functions working with other materials include sheet metal workers, structural and reinforcing iron and metal workers, computer control programmers and operators, machinists, and tool and die makers.

Sources of Additional Information

For information about woodworking occupations, contact local furniture manufacturers, sawmills and planing mills, cabinetmaking or millwork firms, lumber dealers, a local of one of the unions mentioned above, or the nearest office of the State employment service.